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Engineer, U. S. Reclamation Service

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By Weston Gavett

Making Final 15-Ft. Addition to Spaulding Dam
By I. C. Steele

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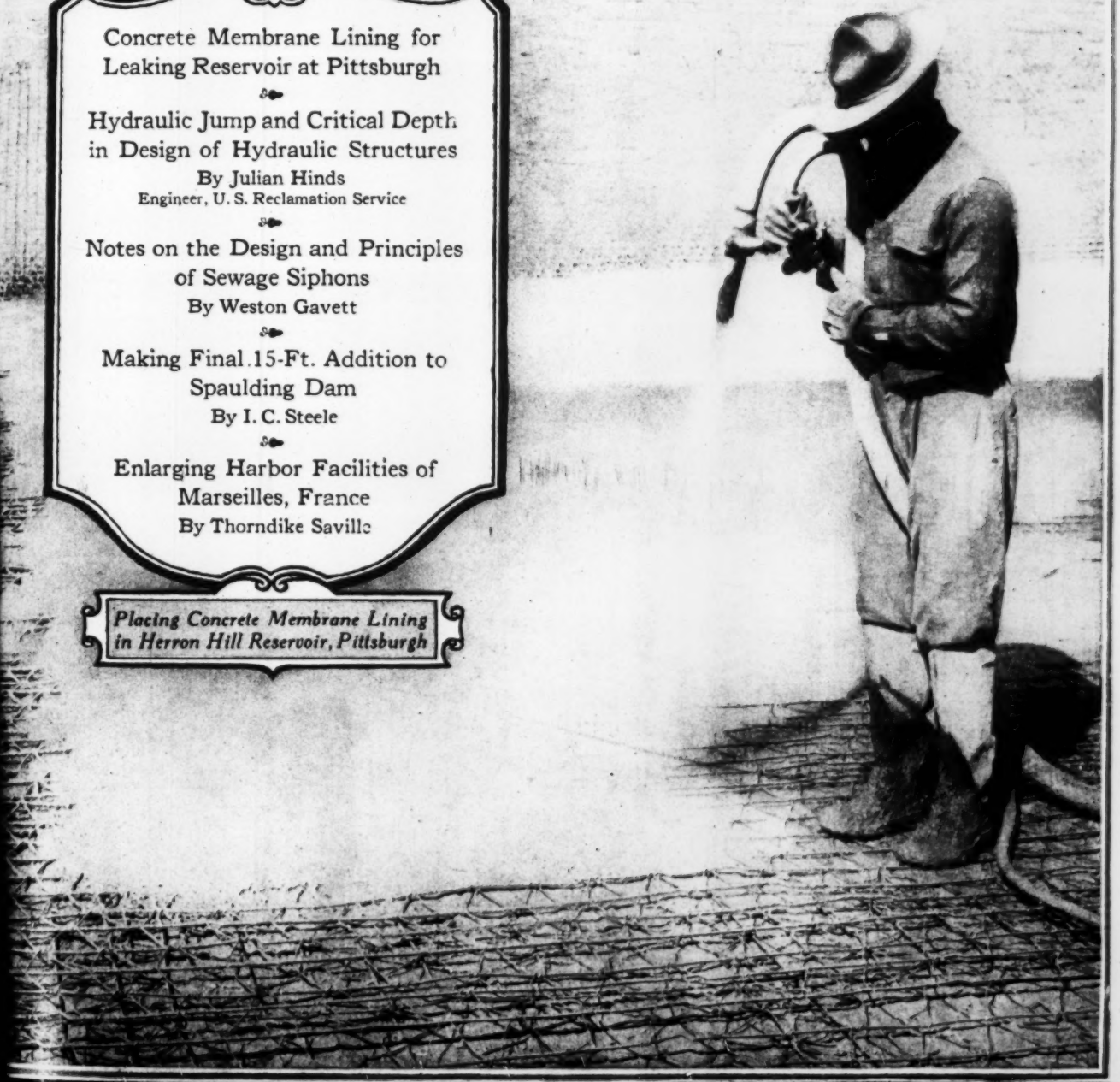
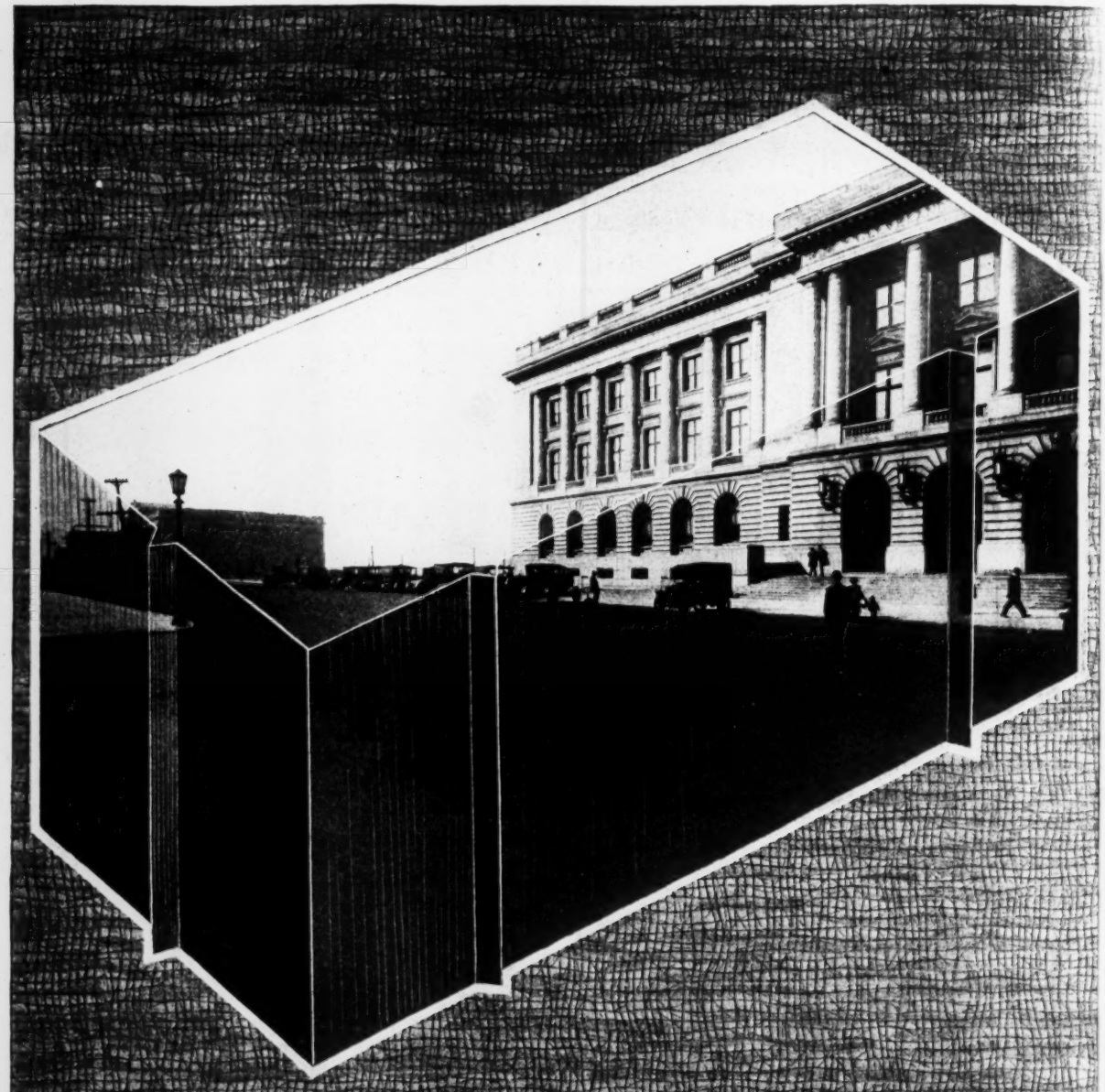


Placing Concrete Membrane Lining in Herron Hill Reservoir, Pittsburgh

November 25, 1920



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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Let Highway Contracts Early

WITH the experiences of this year in mind one would expect that highway engineers would plan to let their next season's contracts early. Inquiry, however, indicates that such is not the case. Only here and there is next season's program determined. The reasons given vary. In some cases the departments are waiting for lower prices and will not determine their programs until the decreases appear. In other cases, no reasons are given. If departments propose to do work next year, they should definitely arrange to invite bids in January and February. That requires that the program be at once determined and the letting details be taken in hand. What important decrease there may be in prices will probably materialize by Jan. 15. Early letting not only will insure an early spring start, but will allow materials to be put on the ground in advance and will give the materials producers and equipment manufacturers early warning of what the road program will demand of them. If work is to be done at all next year, wisdom demands early letting. Lower prices secured by delay are likely to be offset by losses due to inability to get the work done within the season's limits.

An Active Society

HOW engineering societies can grow and flourish is shown by a recent circular of the Western Society of Engineers. It listed for the period between Nov. 4 and Nov. 18, both inclusive, no less than nine meetings. Six of them were regular evening meetings, the variety of subjects being aimed to attract different groups in the membership. One was a luncheon gathering, another a Saturday afternoon "young men's forum," and one an informal "ladies' night." Such activity, of course, requires a large membership and a lot of hard work, but it shows what can be done when the combination is obtained.

Engineers and Labor

GENERAL interest was excited last week when it was reported that the American Federation of Labor had asked Mr. Hoover to discuss with its executive council the present economic and industrial conditions as affecting labor. The incident, however, is but one step in a two-year development in labor ranks, that development being a growing appreciation by the leaders of the federation of the need for adopting and pursuing a sound and broad industrial policy. The movement can be said to have begun when a small group of eastern mechanical engineers successfully argued with officers of the federation the responsibility and interest of labor in an increased production program. Following that came a production plank in the federation's "bill of rights," upon which radical forward step the *Engineering News-Record* commented at the time. More recently has come the best indication of labor's changing point of view—in the publication, under the joint auspices of officers of the federation and of a number of engineers, of the September number of the *Annals* of the American Academy of Political and Social Science. The volume was devoted to a discussion of labor and industrial problems. Production was the keynote and it was emphasized by federation leaders as well as by the engineers. Mr. Hoover's invitation to labor's conference is evidence, also, of the growing appreciation by labor of the place the engineer holds in the industrial structure. All of which is a hopeful sign indeed. If the federation's leaders are wise they will continue to work along these sound lines. If they can induce their members to give of their best the unions will win such public support that they can sweep all before them.

Ousting the Radicals

ANOTHER favorable movement in the federation is the determination to depose the radicals. The latter had bored from within during the war. Mr. Gompers was forced to assent to policies of which he did not approve. In labor circles, as elsewhere, opinion and action are now swinging away from war radicalism. The conservatives, or should we say the non-radicals, are again in control. Fitzpatrick and Foster, of steel-strike notoriety, have been ousted and saner heads installed. Importation of foreign radicals is opposed, indicating that Bolshevistic infection is no longer to be courted or tolerated. It is reason for congratulation.

An Industrial Symposium

REFERENCE has been made above to the September number of the *Annals*. Everyone interested in labor problems should read it. Morris L. Cooke, of Philadelphia, Mr. Gompers and Fred T. Miller, president of the American Society of Mechanical Engineers, are the editors. An attempt has been made to present forward-looking thought on labor, management and production. The contributions are by well-known labor leaders, industrial engineers, managers and economists. As is to be expected, there are some articles tinged with the old spread-eaglism regarding "labor's rights" and, on the other hand, some of the long-haired variety. These are overbalanced, however, by contributions that go with unusual clearness to the core of the industrial problem and mince words neither for the employee nor the employer. The prefaces by Mr. Cooke and Mr. Gompers, and the articles by Arthur J. Todd, William M. Leiserson, Leon Ardzrooni, W. A. Appleton and Horace B. Drury, are especially worth reading. All in all, the articles leave one with the impression that engineers can do much, working with labor, in the formulation of a sound industrial program, and that the recognition has become clear that wages alone are becoming less and less a permanent motive for high production. The beginning made in the liaison between labor and the engineer is promising.

The Public's Dollars

COMMENT has been made in these columns on the passage on Nov. 2 of large bond-issue measures. One other observation, though, needs to be made—that while many issues carried, there was evidence that indicated a change in attitude on the part of the public. Take, for example, the Missouri case. A $60,000,000 highway bond issue was before the people. In a total vote of little over half a million the favorable majority was only about 10,000. Contrasted with the overwhelming votes in northern states one year and two years ago this is an indication that the public's dollar is being more closely scrutinized than before. The attitude is in tune with the spirit of these recent months, when the public generally has been counting its pennies more closely than for some years. Without a doubt, too, this presages a more careful scrutiny of what the people get for their public expenditures.

Concrete in Cold Weather

THIS is the time of the year when warnings about frozen concrete should be most freely given. When it is definitely and continuously cold only the most ignorant and careless will attempt to make concrete and remove forms without due respect for freezing, but now the warm mid-day is apt to make the constructor forget the cool mornings and cold nights which retard setting just enough to reduce strength below the safe limit. An added warning may be worth while. The only certain way to insure against cold weather in concreting is to provide heat—heat in the aggregate and in the water and heat in the structure during the setting period. There are chemicals which lower the freezing temperature of concrete, but their advantage is indeterminate and at best small. Little dependence can be placed in them as a total defense. They may serve as a partial defense when temperature reductions are small, but if their use leads to neglect of more certain precautions they inspire an unwarranted confidence.

Huge Profit-Sharing Scheme

REPORTS regarding the basis of settlement of the British coal miners' strike, commented on in the *Engineering News-Record* of Nov. 4, were correct. The whole coal-mining industry of Great Britain is to go on a profit-sharing basis—and that with government approval and co-operation. A scheme for the regulation of wages "having regard, among other considerations, to the profits of the industry and to the principles upon which any surplus profits are to be dealt with" is to be prepared for submission to the government as soon as possible, but not later than March 31 next. Meanwhile wage increases of two shillings per shift are granted, but beginning Jan. 3 wages are to be decreased or increased in accordance with the total value of export coal produced, the increment being sixpence per shift for each excess of £288,000 over the value for the September quarter. For maintenance of the value of the September quarter an increase of one shilling is to be allowed. Export coal is taken as the basis because domestic coal is sold practically at cost. Adjustments of wages are to be made monthly. The mine owners, at the same time, go on a sliding scale as to profits. At present, under government control, the owners receive 10 per cent of the excess profits. They agree to a deduction therefrom, or are to receive an addition thereto, of one-quarter of said 10 per cent for every sixpence by which the men's advance is reduced or increased. In other words, the owners have the same interest as the men in increasing production. The step is an important one in labor history. With government sanction, labor in a great industry in a nation of 40,000,000 people has been placed on a profit-sharing basis.

Activated-Sludge in England

APPROVAL by the British Ministry of Health of plans submitted by an eminent consulting engineer for an activated-sludge plant for Reading, England, is taken by our London contemporary, *The Surveyor*, as equivalent to placing the "final official seal of approval" on "a comparatively new process of sewage treatment." There are a number of activated-sludge installations in England, but they are of small capacity in comparison with the presumable size of the projected plant for Reading, which is to treat all the sewage of that town of nearly a hundred thousand people. The adoption of the new process at Reading is all the more interesting because that town long had and perhaps still has, one of the notable sewage farms of England. When visited by one of the editors of this journal in 1904 the farm comprised 869 acres, of which 450 received sewage, but with only 380 acres underdrained. An average of 70 men and boys were employed on the farm, with 100 at harvest time. The wage for all-the-year employees averaged 16 shillings or $3.90 a week, besides house, garden and 80 shillings ($19.40) extra at Michelmas. The working hours were from 6 to 5:30 in summer and 7 to 5 in winter. The farm showed a profit occasionally, but was carrying a debit balance. ("British Sewage Works," by M. N. Baker.) If sewage farming has been continued at Reading all these years it is no wonder that a change is now to be made, in view of the high price of labor and presumably the difficulty of getting sufficient labor at any price. In any event, the adoption of the activated-sludge process for all the sewage of so large a British town, with sanction of the necessary loan by the Ministry of Health (successor to the Local Government Board) is something that may well be noted by American engineers.

Winter Storage for Road Construction

ADVICE to accumulate and store road-building materials ahead of construction deserves greater consideration this winter than it has previously received. In nearly every section of the country, this year, highway-construction programs have been curtailed by transportation shortage. While improvements in railway service may be expected, no contractor who faces the facts squarely can risk the chance that this improvement will be great enough to meet in 1921 the requirements of a mileage much greater than that recorded in 1920. Other means than increased car service must be developed to keep next season's highway contracts supplied with materials; one of these means is winter stock-piling.

Winter stock-piling is an attractive idea. It creates visions of intensive utilization of railway equipment at a season when it is free from other service; of increased profits from greater speed and continuity of construction, and of a frequent turnover of capital. These visions, moreover, can be made realities, not always, but under favorable conditions. To determine the proper conditions is as definitely an engineering problem as is

any other in highway construction. In a sentence, winter stock-piling is not a panacea; it is merely an efficacious remedy, under certain conditions, for well-diagnosed ills.

The possible gains from success have been summarized. But success depends upon realizing certain influencing factors and in estimating in advance their force. Can the sources of materials supply naturally tributary to the work be called upon for winter shipments? If the contractor must go farther abroad his costs are increased. Winter storage costs extra in handling charges, and (for cement) in warehousing and the risk of loss or damage. Admitting that these extra costs are returned with a profit because of greater speed and continuity of construction, a different plan of financing the contract is nevertheless required. If aggregates can be secured and stock-piled, can the cement be secured and warehoused or may current shipments of cement be depended upon to keep the work progressing? Instances can be cited where full stocks of aggregate placed on the job last winter have remained unused all summer because cement shipments failed. Will the state or county pay full or partial estimates on materials in stock? Is it physically possible under the plan of operations to accommodate extensive stocks? This list of queries can be extended, but it is sufficiently long to indicate clearly the thought which must be accentuated.

Winter stock-piling for highway construction involves the preparation in advance of a definite plan for storage and the co-ordination of this plan with the broad plan for financing, equipping and proceeding with construction. Stock storage in large volume is not an operation which can at will be successfully grafted onto a construction plan devised originally without the thought of stock storage in mind. This truth explains, partially at least, why, with work under way, contractors last winter responded with scant enthusiasm to the efforts of certain state highway departments to encourage winter stock-piling by offering to pay estimates on materials put in storage.

Will it pay contractors to store road materials ahead of construction? The question cannot be answered by a categorical yes or no. In general, under the conditions which today limit progress in highway construction, any means which will largely reduce the periods of delay will show a profit on any reasonable investment. Winter stock-piling is a possible means.

A Profitable Investment in Steel-Bridge Practice

PROPOSALS have recently been made by a committee of the American Railway Engineering Association that the carrying capacity of existing bridges be rated on the basis of unit-stresses ranging up to 26,000 lb. per square inch. Such stresses represent a very thorough utilization of the material. It is gratifying that such high efficiency should be within reach, but it may be said that in its faith in high stresses the committee is quite in line with modern tendencies of structural thought. Steel is the civil engineer's most costly material, and its price will not permit of any waste. However, high unit-stresses are safe only so long as all the stress effects arising in service are known with a satisfactory degree of precision.

There is none too great a margin between 26,000 pounds per square inch and stress figures at which a bridge would become crippled or would fail. What margin remains is needed to cover contingencies of material and service, and leaves no room for ignoring any tangible stress elements. Under these circumstances an essential part of the dead-load stress in a bridge claims renewed attention, particularly so because means are available, at very small cost, by which definite knowledge concerning this element of stress can be obtained. We refer to the secondary stresses created during the erection of the bridge, the stresses which are caused by the distortion of the structure from the shape in which its parts are joined together to its free or unsupported shape.

Ordinarily the bridge engineer finds his greatest difficulties in connection with the stresses developed by live load. But these stresses are all susceptible of measurement, work that is fairly simple and can be done at any time during the life of a bridge. If, then, careful theoretical analysis of a structure is supplemented by field measurements of stress under loads, the engineer can reach very satisfactory assurance that the effects produced by traffic are all accounted for. The case stands otherwise with dead-load stresses, and for this reason, though ordinarily regarded as least serious, these latter are the essential critical factors when the utilization of steel approaches the elastic limit.

Since dead-load stresses cannot be measured after the structure is in service, they can be known by presumption only. We have fairly good reason for depending on the correctness of calculation with regard to the primary dead-load stresses. On the other hand, complete uncertainty envelops us in the matter of the secondary dead-load stresses. They cannot be computed —partly because the starting point, the unstrained shape of the structure, is not known. It follows almost as an inescapable conclusion that they should be measured. Only by this means can high unit-stresses be employed with safety, and the steel utilized with maximum efficiency.

Gage points for the measurement of dead-load stresses must be applied to a structure before its erection. However, engineers charged with building and maintaining structures have not yet generally accepted the idea that it is a justifiable expenditure to provide such gage points and make the initial measurements on them. It was brought out recently in the discussion of the reinforcement work done on the Niagara railway arch that gage points can be established on bridge members for as little as a dollar or two per pair (or per single gage length.) Since the initial measurements would not add heavily to this cost, it is quite clear that the preparatory work for giving complete future knowledge of dead-load stresses in a bridge (and consequently of the total stresses) can be done at a cost so low as to be completely negligible.

To secure a given degree of strength or safety in a bridge will cost very much less when initial gage points are established on the members than when this preparatory step is omitted and the resulting uncertainty is covered by adding more metal. This statement, briefly summarizing the known facts of the case, gives the answer to the problem of attaining structural efficiency by high working stresses. It means also that gage points and initial measurements on bridge members will always prove a profitable investment, and that bridge practice may well make them part of its standard equipment.

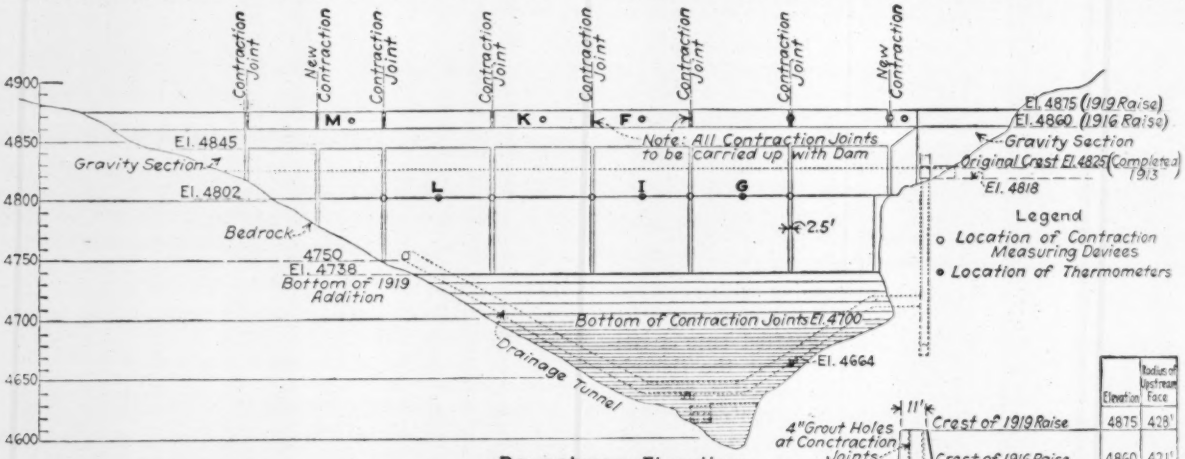
Making the Final 15-Ft. Raise of the Spaulding Dam

Dam Is Now 275 Ft. High—Careful Measurements Taken to Observe Shrinkage of Concrete in the Section Added Downstream for Increasing Strength

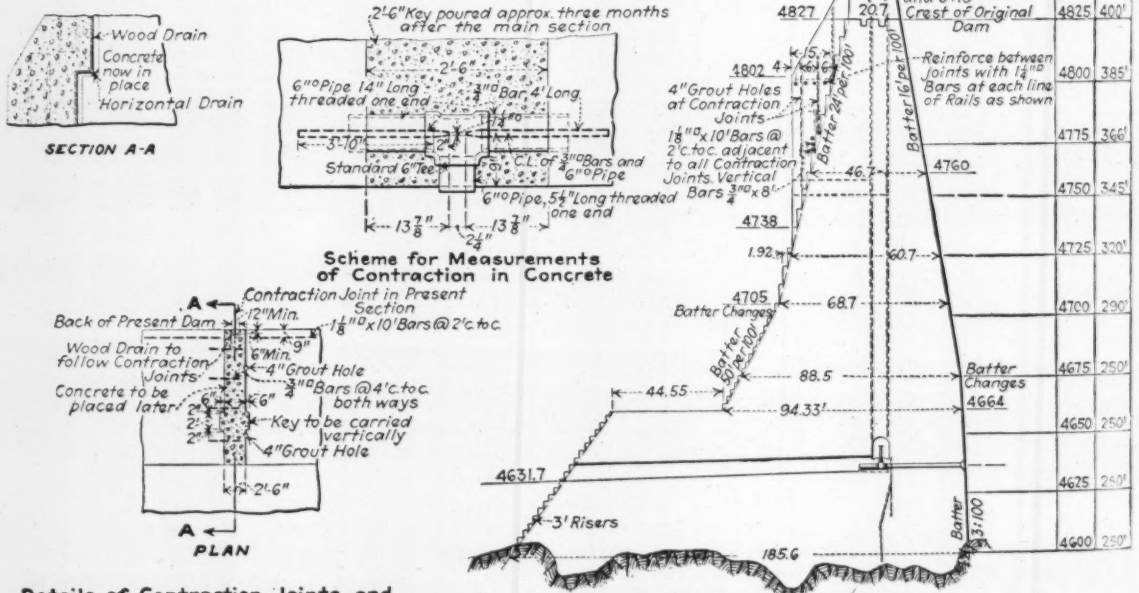
BY I. C. STEELE
Civil Engineer, Pacific Gas & Electric Co., San Francisco, Cal.

AN ADDITION of 15 ft. in height has recently been made to the Lake Spaulding Dam of the Pacific Gas & Electric Co. Lake Spaulding is located in Nevada County, California, on the South Fork of the Yuba River. It is impounded by the main dam flanked by a chain of smaller dams known as dams 2, 3, 4 and 5. The stored water is passed through a series of four power houses with an aggregate head of 2,430 ft. and is then used for irrigation purposes. This raise brings the dam up to a total height of 275 ft. above the bed of the river and provides a storage of 74,000 acre-feet.

The original plans called for a dam 305 ft. high, as described in *Engineering Record*, Aug. 9, 1913, p. 150, and *Engineering News*, Dec. 11, 1913, p. 1163. The dam was constructed to a height of 225 ft. in December, 1913, the foundation being built to carry the ultimate section as planned. During 1916 the dam was raised 35 ft. by an addition to the top of the dam, bringing its height up to 260 ft. The addition recently completed will undoubtedly be the last because of the fact that storage can be developed more economically at other places on the watershed. Any further additions in the height



Downstream Elevation



Maximum Cross Section

Scheme for Measurements of Contraction in Concrete

Details of Contraction Joints and Drains on Downstream Face of Dam

DETAILS OF LAKE SPAULDING DAM SHOWING METHODS OF ADDING TO HEIGHT

of the present Spaulding dam would probably necessitate the reinforcement of the entire arch beginning at the foundation as laid in 1913, thereby requiring a large expenditure for a comparatively small quantity of storage.

The last addition consisted in raising and "backing up" the main dam, together with the smaller dams. This work was carried on and completed during 1919.

The work on the main dam naturally attracts the greatest interest. The final plan called for an addition 15 ft. in height by continuing the upstream and downstream batters. These batters are 3 ft. and 16 ft. in 100 ft. respectively. The crest is now at El. 4,875 and is 11 ft. in width. In addition to this, the arch section of the dam was reinforced for a vertical height of 107 ft. above El. 4,738, by an added section on the down-

MAIN SPAULDING DAM IN 1917 BEFORE FINAL RAISE WAS STARTED

stream face. This concrete section has a maximum thickness of 15 ft. at El. 4,802 and tapers down to 3 ft. at the bottom and to an apparent feather edge at the top of the section. A horizontal notch 4 in. deep and 24 in. high was cut in the old concrete along the top of the reinforcing rib to protect the new concrete from local destruction due to freezing. This arch reinforcement has a tangent gravity section abutment at either end of the dam, it being impractical to carry the arch through to the natural rock, because of the topography of the site.

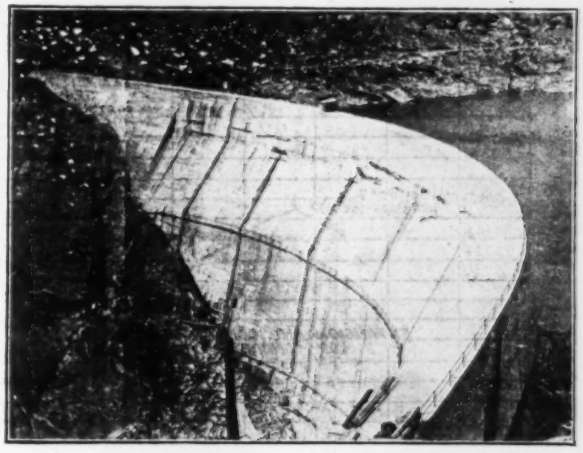
Several interesting problems arose in designing the addition of the main dam, the most important being the necessity to make the reinforcing section in back of the old section take a proper share of the stress.

The new concrete would naturally contract quite rapidly for two or three months and more slowly for a considerable time thereafter. Obviously any appreciable contraction cracks unless grouted would cause a reduction in the load carried by the arch reinforcement and an increased load on the old section.

In addition to this difficulty, another feature had to be taken care of. The water level in the reservoir was being constantly lowered from the beginning of the construction work, which was started early in June, 1919, when the lake was full. It was necessary to complete the job in about six months' time, as the first snows generally fall in November and excessive runoffs have occurred in January and February. It would be impossible to delay concreting until the lake was drawn down to allow the dam, which deflects about ¾ in. at the top under full load, to spring back sufficiently to assure even a comparatively uniform distribution of stress over the old and new section regardless of the shortening of the new reinforcing rib due to contraction. Consequently the purpose for which the reinforcing rib was designed would be defeated.

To solve these problems, open spaces or keyways 30 in. wide were left opposite each contraction joint of the old dam, these being about 80 ft. apart. These keyways were to be closed after practically all the shrinkage in the concrete due to setting had occurred and the temperature fallen to normal. The concrete in these keyways was held to one 80-ft. section by means of short ¾-in. square corrugated bar dowels at about 4-ft. centers in order to throw all further contraction into the joint between the key and the other 80-ft. section. Grout holes were provided in the latter, to be pressure grouted during the low-water period of the following year.

Devices were placed in the keyways at El. 4,800 whereby the actual contraction in the various sections could be measured to a thousandth of an inch with inside micrometer calipers. These devices consisted of a ¾-in. rod protruding from each concrete section with



RAISED MAIN DAM SHOWING ADDED SECTION ON DOWNSTREAM FACE

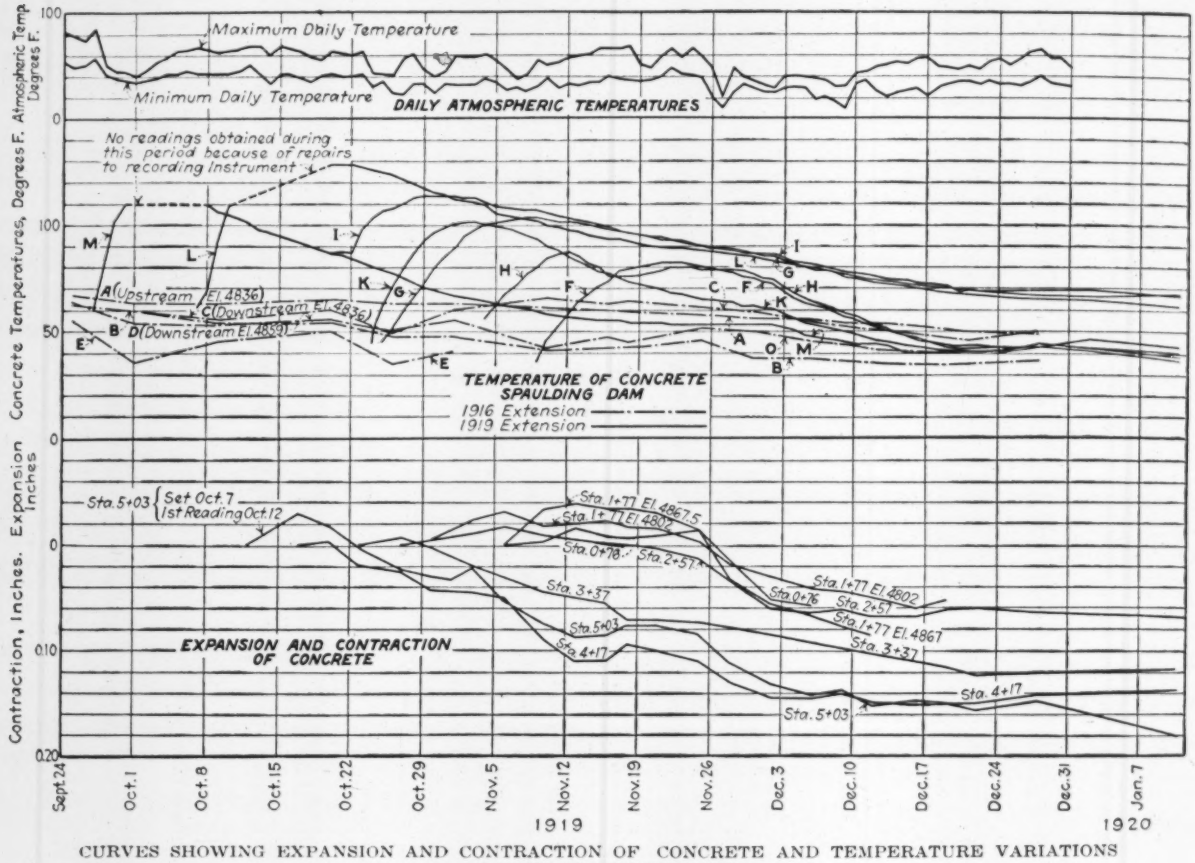
milled ends placed about 2¼ in. apart. These rods were surrounded by 6-in. screw pipes with a 6-in. Tee and a 6-in. nipple, which extended flush with the back of the dam. The ends of the pipe were unthreaded and set a couple of inches into the 80-ft. sections. Seven readings were taken at each observation and averaged. The curves shown herewith give the result of the readings taken. In some cases the first or zero reading was not taken immediately after the apparatus was set.

These contraction readings indicate the contraction taking place at the outer edge of the section only and do not give any indication of what it might be close to the back of the old dam. Examination of the contact between the new and old concrete at the keys just previous to pouring the keys disclosed very slight cracks or lines of separation. These might indicate failure in bond between the new and old work due to contraction, though this is doubtful. The back face of the dam has been constructed in steps with steel rails protruding 4 or 5 ft. at 8-ft. centers vertically and 6-ft. centers horizontally. These were broken off where they were within 3 ft. of the edge of the keys in the new work and 1¼-in. square twisted bars 10 ft. long were placed hori-

zontally, parallel to and 1 ft. from the back face of the old concrete at 2-ft. centers vertically to prevent a tension failure in the vicinity of the keys due to the bond between the new and old concrete. Otherwise any possible failure in bond along the plane of contact between new and old work was not considered to be serious.

In addition to the provision for measuring the construction, it was desired to determine when the temperature of the concrete in the new work was approximately the same as that of the old concrete, for has been disregarded. The wheatstone bridge originally read from 15 ° to 100° (F.) but was changed to read up to 125° as soon as it was found that the temperatures were rising above the limit of the bridge.

The curves shown herewith give the results of all thermometer readings and contraction measurements. It must be borne in mind that the concrete in one section was in nearly all cases poured some time in advance of the adjoining section and that the measuring apparatus could not be completely installed until the last section had been brought up to the required level.



CURVES SHOWING EXPANSION AND CONTRACTION OF CONCRETE AND TEMPERATURE VARIATIONS IN LAKE SPAULDING DAM

when this condition was reached it would be quite probable that most of the shrinkage had been attained and the proper time for pouring the keys determined.

Thermocouples were placed in the new concrete, at the center of each 80-ft. section transversely and at El. 4,867.5 for the top section and El. 4,802 for the reinforcing rib. These were placed in pairs. Similar coils were already set at Sta. 2+97 in the 35-ft. raise of 1916 at various elevations and depths from the faces of the dam. Lead covered copper wires were carried from the coils to the crest of the dam where readings were taken with a wheatstone bridge, which had been calibrated to give the temperature of the coils. All temperature coils were tested to within 1° with the atmospheric temperature before being installed and all tabulated readings are the average of each pair set. In all cases except one there was very little variation between each two coils, the maximum being about 3 deg., most of them checking within one degree. One thermocoil placed in 1916 read 10° high continually and this Hence, in most cases, the first section of concrete poured had time to fully expand by the time the initial reading was taken.

The accompanying table indicates the dates of setting and positions of the thermo-couples together with the initial reading.

Thermo-Couple	Elev.	Date of Setting	Initial Reading — Date	Initial Reading — Degrees (F)
M	4867.5	Sept. 27, 1919	Sept. 27, 1919	59½
I	4802	Oct. 15, 1919	Oct. 20, 1919	86½
L	4802	Oct. 7, 1919	Oct. 7, 1919	60½
H	4867.5	Nov. 4, 1919	Nov. 4, 1919	56
K	4867.5	Oct. 24, 1919	Oct. 24, 1919	44½
G	4802	Oct. 25, 1919	Oct. 25, 1919	45½
F	4867.5	Nov. 8, 1919	Nov. 8, 1919	36½

An appreciable increase in temperature was noticed in the 1916 concrete about two weeks after the new concrete was poured against this section. First thermometer "C," El. 4,836 and 3 ft. in from the back face, rose and then "B", located in the middle at El. 4,836, rose slightly.

In the early half of December, 1919, a big storm broke, continuing for several days, and it was feared

that an excessive runoff might occur before the keys were poured and set sufficiently; also, though of lesser importance, that the heavy snows and freezing weather would prevent the proper placing of the concrete. Some of the sections were about 60 days old and the contraction curves indicated that these had practically ceased to contract. The other sections were expected to contract further, but this could be grouted early in 1920, in case of a dangerous run-off, much more rapidly than the keys could be poured, and in case the joints should open up more by the fall of 1920 they could be grouted again by drilling holes every 6 to 10 ft. vertically in the back face of the dam and calking the joint between pipes. It was therefore decided to pour the keys as rapidly as possible and the work was carried through without hindrance, the last of the concrete being placed in the keys on Dec. 23, 1919.

Contraction joints had been provided at about 80 ft. centers in the original concrete. These are at right angles to the tangent of the arch and are offset occasionally to form keys. All but two of these had been grouted in 1916 and were practically watertight. The joints at Stas. 4+17 and 5+03 however could not be grouted, due to the lateness in the season, and these leaked considerably.

Grouting pipes were carried through the concrete keys to these two stations, and during the early part of January, 1920, the joint at Sta. 5+03 was calked and grouted from the upstream face of the dam. The joint had previously been calked up along the back face and the key poured against it. The joint at Sta. 4+17 was treated in the same manner and grouted about the middle of February. In both cases the grout was put in under about 70 lb. pressure and penetrated through the old and new concrete to the back of the reinforcing ring. To do this it had to find its way for 15 in. along the surface of contacts between the old and new concrete and out through the new contraction crack in which vertical holes had been provided for grouting in the winter of 1920. Consequently the entire joints were thoroughly grouted. 153½ sacks of cement and 4 sacks of sand were used at Sta. 5+03 and 200 sacks of cement at Sta. 4+17.

The grout used consisted of neat cement and water mixed in the proportion of about one part cement to two parts water. Some sand was used but proved to be less satisfactory than straight cement.

Drillings to Test Joint Tightness

All the other contraction joints in the main dam are apparently tight. An endeavor was made to drill into the old concrete with a diamond drill in such a manner as to cross the contraction joints at a slight angle. It was thought that the core would indicate whether or not these joints had been thoroughly filled with grout in 1916. This scheme did not work at all satisfactorily, as the drill shattered the concrete and only very short sections of core could be obtained even in the solid concrete. Considering the actual watertightness of the joints and the number of sacks of cement used in grouting them in 1916, it was evident that these joints were quite tight in full bearing. Therefore, no further effort was made to explore them.

Dam 2 is a spillway dam having a spill crest 5 ft. deep and 270 ft. long with 6-in. I-beam posts at 6-ft. centers to support wooden flashboards and a walkway. This dam is arched in plan with a radius of 300 ft. The

RAISED DAMS 3 4 AND 5 FORMING A CONTINUOUS DAM

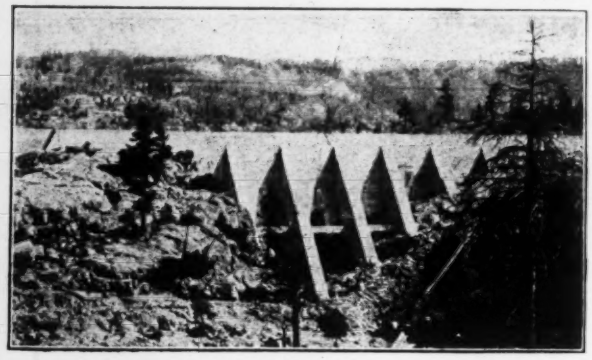
raise was made by backing up the old section sufficiently to make the entire section a gravity section.

Dams 3, 4 and 5 are now continuous and really make one dam, as shown in one of the views.

Dam 3 was previously very low and arched in plan with a radius of 200 ft. This dam spanned a rather deep pot hole. Consequently a buttress 4 ft. wide was placed on either side of the pot hole and sufficient reinforcing placed between to carry the stresses of the intervening section to the buttresses or rock abutments. The top 15 ft. was made a gravity section to conform to Dams 4 and 5, and also because the north end of Dam 3 joined the southerly end of Dam 4 and did not extend to a natural rock abutment.

Dams 4 and 5 were originally gravity sections but arched in plan with a radius of 800 ft. to conform to the topography of the site. These dams were originally poured under very severe weather and working conditions and Dam 5 in particular was very porous and leaked badly. It was decided to construct a buttress type backing instead of a solid section with drains carried out from in back of the buttresses to prevent any possible water pressure on them, and to treat the front face of the dam with gunite to prevent leakage. Consequently, the existing sections were backed up with buttresses 6 ft. thick at 30 ft. centers and a 15-ft. high gravity section placed on top. A reinforced slab 2 ft. thick was placed on the downstream face between the bottom of this latter section and a line 16 ft. lower where the batter of the rear face changed. As this section also formed a part of the upper gravity section the inclined face of the old concrete was stepped to give a proper bearing surface and the section reinforced to take care of the bending between buttresses under the full water pressure which could be exerted at that level.

An interesting question arose in taking care of the shearing stresses at the juncture of the buttresses and the old dam. The T section was figured to act as a gravity section and in order to do so there must be no danger of a shearing failure along this plane. The shear stresses ran from a maximum of 76 lb. per square inch at a point 60 ft. below the top of the finished structure to 8 lb. per square inch 29 ft. higher. Con-



BUTTRESS CONSTRUCTION—DOWNSTREAM FACE OF COMPLETED DAM 4

sequently it was deemed necessary to cut hitches or notches in the old concrete, 6 in. deep and 20 in. high sufficient in number to transmit the shearing stresses from the buttress to the old dam. These were 6 ft. long (the width of the buttresses) and from 4 ft. to 5 ft. centers with the closer spacing at the bottom.

The construction work was principally a problem of organization and transportation. Speed was the controlling factor in the work. Considerable equipment, sheds, buildings, railroad, locomotives, etc., remained on the ground from previous years and were readily put in shape to start work. The smaller dams were constructed first, the water level being kept high enough to float all materials from the delivery chutes at the south end of the main dam. Seven barges and two launches were used for this purpose. Three small mixers of from ¾ to ½ yd. capacity were used. These were mounted on barges with donkey engines and elevator and the materials fed directly into the mixers from adjoining barges.

The work on the main dam was carried on with two 1-yd. mixers, located in the old mixer house constructed in 1912, and one ¾-yd. mixer on the top of the dam, the material for this being transported in ore cars along the top of the dam. The small mixer was used to pour the north end of the top 15-ft. section and a portion of the north and backing section. The concrete from the two larger mixers was carried down in chutes across the back face of the dam. Later, in order to reach the higher section, an elevated tower was built and the concrete hoisted and distributed through a second chute.

Twenty-two thousand four hundred and sixty cubic yards of concrete were placed in the main dam, and 7,886 cu.yd. in the smaller dams. All concrete placed in the last raise was a 1:2½:5 mix, that in the previous work being 1:3:6.

The work was handled under the direction of P. M. Downing as chief engineer of the company. F. G. Baum was consulting engineer. The construction work was done by Duncanson-Harrelson Co. of San Francisco. G. D. Ray was field engineer.

Advice to Freshman Engineers

No man can amount to much as an engineer who cannot write and speak his ideas fluently and clearly in strong, grammatical English. Engineering success is absolutely dependent on ability to convince men in authority that your plans are right.—Dean Anson Marston in the *Iowa Engineer*.

Art in Structures

By George Sydney Binckley
Consulting Engineer, New York City

A brief editorial comment entitled "What Is Art?" in "Engineering News-Record," *Sept. 16, 1920, p. 521, has called forth a variety of comment from readers, some of which has already been published in these columns. The following article was written without knowledge of the current discussion, but it is a clarifying addition to a somewhat confused subject.*—Editor.

AN UNDERSTANDING of the relation of art to structures is important to the engineer even as it is vital to the architect. Far from this relation being one of uncertain quality capable of interpretation only by an artist, the elements of structural design, of the balancing of visible proportions, and of ornamentation are each perfectly separate and distinct, and constitute separate problems which must be treated as such.

By far the greater part of the wretched so-called architecture with which the modern world—and especially the United States—is encumbered, is the natural result of failure to recognize the simple fundamentals which fix and define the relations of art to structures. The purpose of this brief article is merely to show how simple these principles are and to indicate the method of their application.

Fundamentals of Structural Design

In a broad sense, all structures are engineering works. The underlying purpose of all structures is utilitarian—to furnish shelter for men or goods, to provide protection against enemies, or even to placate a god. This implies the very important corollary that each element in a structure must have a function. This is smiply engineering, but it is fundamental to proper structural design, whether it be a crude wall of rough stone, or a huge cantilever bridge.

It is most unfortunate that this simple fact is so little understood by the modern architect, for it is as fundamental to good architecture as to engineering. This principle is necessarily recognized by the engineer, for he deals with forces and the kind and amount of materials required to resist these forces. But architecture is a very old art, and its finest examples are based upon stone, not steel, as the material of construction. The great structural works of the early civilizations were almost exclusively of stone, and the architect of those days realized fully and applied perfectly the fundamental principles given above, with the result that there is perfection of proportion in classic architecture, improvement is impossible.

But the ancient architect dealt with a material which was employed under a factor of safety enormously greater than that generally permissible today. The actual unit stresses to which this material was generally subjected were very low, and the masses correspondingly large. So, although no structural element of ancient architecture is without functional significance, it is actually based upon an assumption of very low unit stress.

The modern engineer, dealing with stresses and materials unknown to the ancients, has run far ahead of any possible artistic development at all comparable to the technical progress made. Our greatest modern engineering structures are bare mathematical skeletons of

an idea. They are merely sketched in with scanty steel along their lines of stress. The beauty of a steel structure is the purely mathematical beauty of science. To a bridge engineer a great steel bridge is probably beautiful, but to the ordinary man of culture and taste it is merely large and very ugly.

Brooklyn Bridge Beautiful

Although we may not see yet how it will ever be possible to put beauty into structural steel, one of the most beautiful structures in the world is the old Brooklyn Bridge. Why is this so?

The answer lies in conscious or unconscious recognition by its designer of the first principle of architectural excellence. For the great catenary is a curve of beauty. From the head of each magnificent stone pier—stone because it resists compression stresses alone—spread fan-like the delicate threads that reach out along the lightly arched roadway. The slender cables are subject to tension only, yet theirs is the greater load, and they are visibly thicker than the subsidiary tension elements. Massive, solid, obviously proportioned to carry to their foundations a great vertical load, the majestic towers are a perfect foil to the airy lightness of the web of steel between and beyond them. This lightness is accentuated by the grace of the cambered roadway, springing as it does from pier to pier and sloping on each side to earth. And, last, the roadway itself even now with the later additions made, suggests in its proportions a perfect relation to its functions and the manner of its support.

Here we see a most perfect blending of engineering and art. It is the more instructive that in this classic structure, beauty of proportion is wholly unsupported by any attempt at ornamentation. And this was the crown of wisdom, for in such a case embellishment would be impertinence.

Simplicity of Design

But the beauty of the Brooklyn Bridge is made possible by the simple mathematical elements of its design. Plain to the eye is the function of tower and steel, and the primitive savage who has seen a vine hanging between two trees would know why this bridge stands. Not so the other great bridges. Vast, impressive, to be accepted, like the crashing and incomprehensible harmonies of Wagner as undeniably great, they cannot be accused of beauty, and to attempt to make them beautiful is on a plane with putting a bearded Cossack in the gauze skirt of a ballet-girl. For some generations to come at least, structural steel would seem hopeless as a basis for beauty.

But with the exceptions of steel, the case is far otherwise, and there is little or no excuse for ugliness. The engineer prescribes the bones and sinews of a structure, and he may or may not have the talent and the training to harmonize its visible proportions in a manner to satisfy the esthetic sense. But it is a worthy subject for his study.

Here we may consider in order the three elements of a structure in which artistic values as well as structural integrity are given weight. These elements are:

First—The general plan of the structure with reference to its purpose, the best use of the space available, the relation of masses, and the influence of the location selected.

Second—The adjustment of the proportions of the visible elements of the structure, in such a manner as to harmonize with and emphasize their functional importance. This involves the relations of openings to solid spaces, of columns and pilasters to lintels and pediments, and of masses, one to another.

Third—The element of decoration or ornamentation.

Of these elements, the first two are in good architecture absolutely essential. But the value of the third is not to be underestimated, for even with the best of general plans, perfect correlation of masses, and skillful adjustment of the relations of all the visible elements of the structure, the total absence of the decorative element will probably result in a cold and forbidding style. The structure might be massive, well balanced in its proportions, majestic and impressive in fact, yet without the lightening touch of a properly subordinated decorative element it would at best be grim and austere.

The Decorative Element

The function of the decorative element is quite as legitimate as that of adjusted proportion, although subordinate to this. Right here is where the average architect fails miserably. To him, a structure is often merely a support and excuse for ornament. The later renaissance period is an extreme development of bad taste in architectural adornment, and the baleful influence of that epoch is with us still.

Yet the decorative element has an important function. The prime requisite to its proper employment, however, is thorough and definite understanding of its relative position. *This position is subordinate.* It must never be allowed to be anything else. Ornamentation must never be employed in a structure merely for its own sake. A structural element should never be subordinated to or be dominated by an ornamental or decorative feature.

The decorative element can only have legitimate use where it is desired by this means to emphasize the proportions or functions of a structural element. In its simplest form, such as a simple capital, it still has a structural significance in emphasizing the distribution of load. The use of ornamental capitals for columns is very ancient, and is capable of relieving the severity of a plain column as nothing else can. Even the grim and tremendous architecture of Egypt did not disdain the plant-motive in their great monelithic columns, and the hieroglyphic inscriptions so freely used, although not originally intended as such, became decorative elements of recognized importance. In Egypt, the relations of masses, of form, and of surfaces were very thoroughly understood, but these vast structures were the works of engineers rather than of artists, and, majestic as they are, theirs is the grim beauty of perfectly proportioned strength and mass.

As far as the Egyptians went in architecture so far it should not alone be the right but the aim of the engineer of today to go. There is every reason why he should cultivate a knowledge and appreciation of the esthetic value of perfect proportions and in his plans give due weight to this factor. There is generally more than one way to design a structure correctly, and that way which is most harmonious to its purpose and location is most likely also to provide a basis for the most beautiful structure. Broad vision that contemplates a great project in all its true relations, will suggest an arrangement of its elements that is not alone the best,

but almost as a consequence the most stately and beautiful. Knowing the purpose and relative significance of each of the elements of his structure the engineer should be even better able than the architect to so adjust their visible relationships as to emphasize and define their functions. This is the legitimate aim of architecture, and may well be compassed by the engineer.

But of attempts at ornamentation, let him beware. It may be irreverent to say so, but of ornamentation also let the architect beware. For the use of the decorative element is the function of an artist who knows architecture—and few engineers, and quite as few architects are artists. The proportions of an opening, the emphasis of a line, the breaking of a surface, or the choice of materials are all legitimately within the field of the architect or the engineer whose taste and training fit him for such work. But to say where, and to what extent, and what kind of embellishment is permissible is purely the function of an artist. A beautifully proportioned structure of absolute simplicity, while perhaps cold and austere, is a thousand times better thus than bedizened with meaningless and absurd ornaments. Decorated with good taste, with true reference to the inherently subordinate rôle of the decorative element, it would gain in beauty and possess a lightness and life lacking in the cold purity of line and mass. Yet just here is where the greatest crimes are committed in the name of architecture.

It is also well for the engineer to remember that he should not strive for picturesque effect, for engineering is a science, while true picturesqueness is not even art—it is essentially casual. Hence when he designs a bridge or a dam, a wall or a powerhouse, he should seek to fit his structure as consistently as possible to its natural setting, always keeping in view its purpose. For the more completely and perfectly this purpose is realized, the more harmonious is the possible result. A great arched dam is a stately and beautiful structure, and it and its appurtenances should not seem to intrude but should grow out of their surroundings, as a part of them. The graceful arch of a bridge should seem to spring from the rock on which it is based, a growth in harmony with its environment, not an excresence.

These things can be done by the engineer who grasps the simple fundamentals of architectural excellence, and if he chooses to follow the pleasant paths of study to this end, he will have no need of the assistance of an architect. And this is desirable, for too often the architect is allowed to obscure noble structural features, and riot in a perverted taste that leads him to bedeck and bedizen a dignified engineering work with masses of meaningless and impertinent ornamentation.

Pressure of Concrete on Forms Measured

In recent measurements of the hydrostatic pressure of concrete by the Bureau of Standards it was found that maximum pressure was caused by the head of concrete existing at the end of about 40 min. from the time of beginning pouring. After that time the pressure decreased, although the head of concrete on the gage increased. The maximum pressure was found to be equivalent to that of a liquid weighing 124 lb. per cubic foot. The tests were made by W. A. Slater and A. T. Goldbeck. A bulletin on the subject will soon be issued by the Bureau.

Outline of Accounting Scheme for Water-Works Utilities

IN a preliminary report the Committee on Uniform Accounting of the New England Water-Works Association submitted to the convention of the association held at Springfield last September an outline of the uniform water-works accounting system. The scheme was prepared after careful consideration of the uniform classifications of accounts for water-works formulated by the Public Service commissions of Maine, New Hampshire, Connecticut, Pennsylvania, New Jersey, Wisconsin, Indiana, California and Washington, and also after having reviewed various reports on this subject. The committee was also guided by the accounting system and classification used since 1913 by the municipal water-works plant of Springfield, Mass., recommended by William J. Hagenah, Chicago, a public utility engineer, statistician and accountant formerly connected with the Public Utility Commission of Wisconsin. The members of the committee already named are Albert L. Sawyer, Haverhill, Mass., Walter B. Schwabe, Thompsonville, Conn., Samuel H. McKenzie, Southington, Conn., Edwin L. Pride, Boston, and Alfred R. Hathaway, water register, Springfield, Mass. The latter compiled the report.

The report states that "it is assumed that the water utility should be a self-supporting enterprise of the municipality, and that "no provision has been made in the accounting scheme" for contribution of municipal funds toward its operation, but this provision can easily be taken care of by the utility's accountant if needed."

The committee's own outline of its accounting scheme is as follows:

A Condensed List and Statement Form for Income and Profit and Loss Accounts — (for monthly and annual use; all accounts on accrual—not cash—basis), including Operating Revenues, Operating Expenses, Non-Operating Revenues, Deductions from Gross Income, Net Income, and Disposition of Net Income.

A Classified List of Income and Profit and Loss Accounts (as shown on above Condensed List), including indicated and given explanation of these accounts, with suggested arrangement and subdivisions, all supporting the condensed list.

A Condensed List of Balance Sheet Accounts (in balance form) showing Assets and Liabilities in condensed balance grouping.

A Classified List of Balance Sheet Accounts, showing Supporting Detail Accounts, with indicated or given explanations of same. *Also under Plant Accounts* is shown a possible and logical analysis of same into various physical and other units, for appraisal purposes when wanted. This analysis conforms to the different steps or processes in sequence of operation of the water utility, and corresponds to the grouping of accounts, which lends itself to the obtaining of proper data for rate and consumption questions, as well as the financial data always needed.

A Condensed Summary Form for Showing Cash Receipts and Expenditures in Annual Reports, under various funds. —This is followed by a supplementary and more detailed form for use in showing funded divisions of such *cash expenditures* where it may be wanted. Where any water utility may find it to be inexpedient to at once adopt and put into practice the suggested scheme of accounting it may, by the use of these forms, obtain at least some uniformity for the comparison of *cash transactions* by its utility operations with the same transactions by another utility, which uniformity is also now sadly lacking. Then, whenever such utility may be in better condition to adopt the accounting system here outlined and suggested (or some other system which may be recommended by the Association), even to the

extent at first of using the grouping accounts, and adding the supporting sub-accounts later, the changes will adapt themselves easily and gradually, and the cash statements can be kept as supplementary statements.

The scheme as given in outline just above is elaborated in some detail in the report of the committee. The report will come up for discussion at one of the 1920-21 meeting of the New England Water Works Association.

Pile Driving Results with Steam and Drop Hammers Compared

OPPORTUNITY for comparison of the results obtained in driving piles with drop and with steam hammers has been afforded on the construction, now in progress, of the Claremont piers of the Lehigh Valley R.R. at Greenville, N. J., and on jetty work for the new Albert locks on the Thames River in England. Data on these projects have been collected by the McKiernan-Terry Drill Co., the source of the following notes:

The Claremont pier terminal in New York Harbor, when completed, will embrace approximately 7 mi. of new work. There is a large amount of dredging involved and the character of the soil makes pile driving difficult. The average run of material is silt, sand, coarse gravel

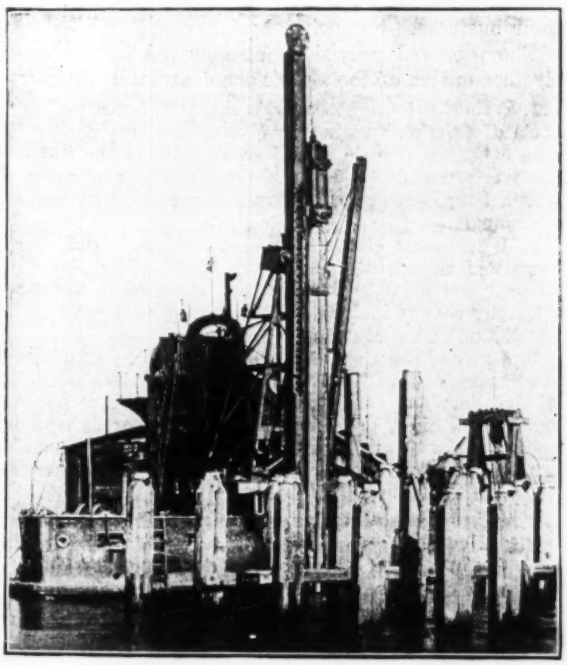


FIG. 1. TIMBER PILES USED ON THAMES RIVER PROJECT

and hardpan, in the order given. Pile driving is being done with three floating rigs, two of which are outfitted with 6,500-lb. drop hammers and a third with a McKiernan-Terry steam hammer of the following description: Net weight, 13,535 lb.; strokes per minute, 120; energy exerted per blow, 17,500 ft.-lb.; over-all height, 10 ft.

It has been found that piles driven with the drop hammers, first jetted practically to their full length, have, at times, a bring-up of from 6 to 10 ft. above grade after driving. Many of them are badly broomed and others are split from 5 to 8 ft. below the butt.

When the heavy steam hammers were first used the piles were all driven to grade without jetting, but,

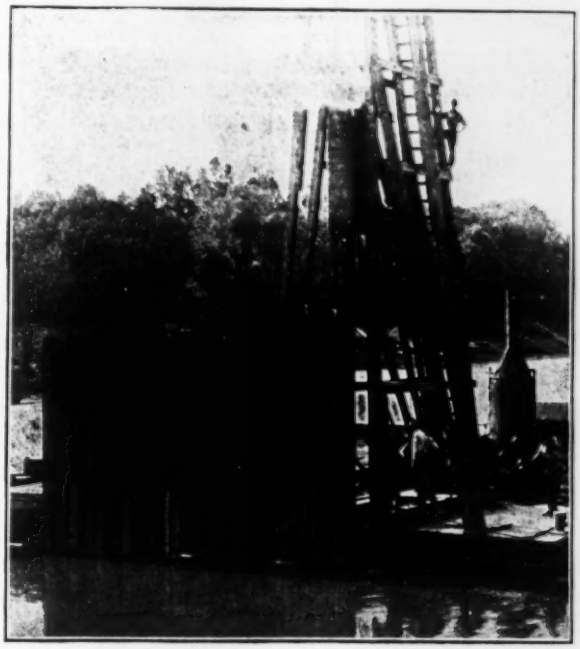


FIG. 2. SHEET PILES DRIVEN 15 FT. BELOW WATER WITH FOLLOWER

owing to the difficult character of the soil, it was found that the alignment was not as good as in the case of jetted piles. Thereafter, a hole about 15 ft. deep was jetted, the pile set in it and driven in accurate alignment to grade with the heavy hammer.

Comparing the work of the heavy steam hammer and the ordinary drop hammer on this job, record of weekly performance gives the drop hammer an average of 35.7 piles per 8-hr. day, and the steam hammer, working under the same conditions, 48 piles per day. During the driving with a 13,000-lb. steam hammer, without jetting, eleven piles were put down consecutively to a total penetration of 426 ft. in 42 min. 8 sec., or an average of 10 ft. per minute. The piles used on this job are from 60 to 70 ft. in length and 16 to 18 in. butt measure.

Another comparison between the drop hammer and the steam hammer is given by the work now being done for the entrance jetty to the new Albert locks, Thames River, England. Timber piles, averaging in length from 64 ft. to 70 ft., each pile being made up of two timbers 15½ in. square, securely bolted together and having a cast-iron shoe weighing 175 lb. embracing the two piles at their ends, are being used on this job. An iron ring surrounds a reduced section at the top of the pile for driving.

When the work was started a 5-ton drop hammer was used. According to the British engineer in charge, piles were driven through material consisting of river mud, clayey sand, gravel—locally known as "Thames ballast"—to the chalk level. Probably the hardest driving for the piles was through 25 ft. of this "Thames ballast." Coupled with the hard driving encountered was the fact that only three or four hours were available in which to drive, owing to tidal conditions. The drop hammers took an average of 3½ days to each pile, while the steam hammer drove two piles per day.

On nine of the twelve piers being built at Stapleton, Staten Island, New York City, steam hammers are being

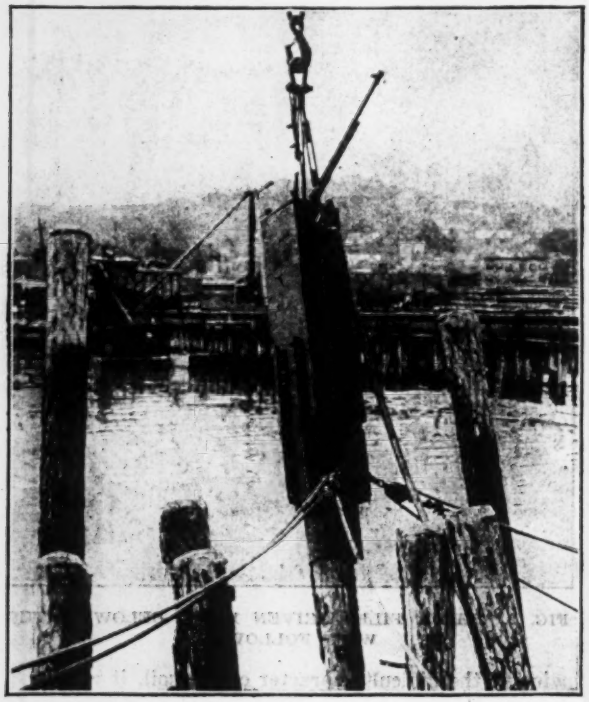


FIG. 3. STEAM HAMMER IN THREE-POINT SUSPENSION DRIVES BATTER PILES

used. Here the particular type has a net weight of 6,800 lb., 140 strokes per minute, exerts an energy per blow of 7,800 ft.-lb., has an over-all height of 92 in., and a cylinder stroke of 16 in. Two of these hammers have been rigged to drive batter piles, as shown in Fig. 3, the hammer being rigged on a three-point suspension by means of a bridle which is attached to the hub of the derrick line. By the method of rigging shown the hammer hangs at a fixed angle and by means of a turnbuckle the angle can be changed as desired. The pipe sleeve makes a guide for the hammer and holds it in place while driving. The three-point suspension relieves the leverage on the bottom of the pile so that it is readily driven to the predetermined angle merely by lowering the hammer. The piles are all approximately 50 ft. in length and are driven to an average penetration of 25 ft. The city inspector in charge of the pile driving work states that the steam hammer with the attachment herein described drives two piles to one driven with a drop hammer.

Less Forest Fire Loss During 1920

No loss of timber or equipment has occurred in the territory comprising several million acres protected by 66 wardens maintained by the Western Forestry and Conservation Association, and in general the forest-fire loss in the Northwest has been less this year than last. Washington has had 754 fires in 1920 against 847 in 1919 and lost less than 42,000,000 ft. of timber, compared to 60,000,000 ft. last year. Of the 754 fires, 120 were due to campers, 74 to lightning, 60 to cigarettes. There has been an unusual proportion of lightning fires in Oregon this year but less loss than last year. The same is true of Montana and of other western states.

New York Contractors Disapprove Proposed Contract Provisions

AT a recent meeting of the executive committee of the New York General Contractors Association the proposed contract provisions submitted by the committee on contracts of the Associated General Contractors, and noted in *Engineering News-Record* June 3, p. 1119, were presented for discussion and those proposed provisions referring to freight rate, wage scale and material price changes were disapproved. Failure to approve these particular provisions lay in the fact that they could only be made applicable to public works by legislation; and on private work would tend toward the adoption of a cost-plus contract, to which the majority of the members of the committee are opposed as a general proposition.

Regarding the cost-plus contract, the committee seems to agree that while such a contract is advantageous under certain conditions, when handled by a contractor of approved reliability and experience, the general adoption of such a form of contract would lead to gross extravagance and carelessness in the conduct of the work, says a recent issue of the *Bulletin* of the Associated General Contractors. It is contended that a general adoption of the cost-plus form of contract would react against those firms who have built up their businesses on such a basis.

The proposed provisions disapproved by the executive committee of the New York contractors follow:

1. *Freight rate changes.*—Bids should be submitted on the basis of existing freight rates, with the provision that in case a change in rate should occur between the time bids are received and the date fixed for the completion of the contract the contract price should be increased or decreased accordingly.

2. *Wage scale changes.*—Bids should be stated and be submitted on existing wage rates, with the provision that the contract price be increased or decreased in accordance with any change in such rate before the date fixed for the completion of the contract.

3. *Material price changes.*—Bids should be submitted on the basis of existing prices for materials f.o.b. the producer's plant or distributor's yard, with the provision that the contract price shall be increased or decreased in accordance with any change in such price that takes place within the time allowed the contractor to purchase and fabricate his material.

The proposed revisions relating to changes in quantities was not approved. The committee felt that, particularly on large contracts, where the contractor would be reimbursed were the unit quantities smaller by a stated amount than the estimate, and the unit prices would be decreased were the unit amounts found to be larger beyond a certain limit than estimates, the incentive would be lacking to build efficient organizations or to devise methods of handling work more economically than one's competitor. This particular provision would mean, the committee believed, contracts would be placed on a basis of absolute assured profit.

In the matter of changed quantities the executive committee proposed that items for plant expense and overhead expense be incorporated in bids. These are the two items that are most affected by any reduction in the quantities, particularly when those quantities happen to be the ones on which the contractor distributed most of his plant and overhead expense. The contractor would bid a lump sum for these two items and payment would be made monthly as the work progressed. In this

way any decrease in quantity would not deprive him of any portion of his overhead. Such a plan would not need any legislative enactment but would be entirely in the discretion of the engineer drawing the contract. The committee agreed that there was obvious disadvantages of such a proposal, such as the attempt to overload the item and render the bids subject to criticism as being unbalanced.

Another point on which the New York executive committee failed to become enthusiastic was that one concerning arbitration. The constitutional inability of avoiding court action through the insertion of an arbitration clause providing that the arbitration award be final and binding the committee believed would have as a net result a condition wherein the winner in the arbitration award would pay for two actions—the arbitration and the lawsuit.

Object and Powers of International Hydrographic Bureau

AT A meeting of the Board of Surveys and Maps held in Washington Oct. 12 the Committee on Hydrographic Charts, in submitting its report, pointed to the importance of the International Hydrographic Bureau, now being established. This bureau is to be maintained jointly by all nations having an "interest and concern in hydrographic charts and other navigational data." Its object and powers are stated in the report to be, essentially:

The establishment of a close and permanent association between the hydrographic services of the associated states, to co-ordinate their efforts with a view to rendering navigation easier and safer in all of the seas of the world, to cause the national offices to adopt the resolutions taken by the various international hydrographic conferences, to try to obtain uniformity as far as is possible in hydrographic documents, and finally, to advance the theory and practice of the science of hydrography.

The International Hydrographic Bureau shall keep itself in direct and close communication with the national services of the associated States.

The principal subjects which should be studied by the International Hydrographic Bureau are the following:

(a) The production of documents published by hydrographic offices.

(b) The drawing up and publication of various lists, such as of geographical positions, primary and secondary meridians, time signals, etc.

(c) The construction and use of hydrographic instruments and methods of hydrographic surveying, the principles of which have been approved by a national office.

(d) Researches on the subject of the constitution of the earth, in so far as it affects hydrography.

In reference to co-ordination of work the report states that it is the object of the International Hydrographic Bureau to obtain as much uniformity as possible in the documents published by the various national offices and to propagate the methods of making hydrographic surveys, and to encourage all proposals tending to this end, and also itself to propose efficient solutions and endeavor to have these solutions adopted.

In order that the Board of Surveys and Maps may have it on its official files there is appended to this report part of the report of the organizing committee which sets out the "objects and powers" of the International Hydrographic Bureau. Prominence has been given to this feature of the report for the reason that the navigation charts of each country are of concern and importance to the navigators of every maritime nation.

Trend of Highway Development —a Survey

Practice in Nebraska and Iowa

THIS IS THE THIRD of a series of staff articles on the highway situation. It discusses the general substitution of tractors for teams in earth road grading in Nebraska and the satisfactory results obtained from the truck patrol system.

The chief points of interest in Iowa's practice are the successful use of pit-run gravel for concrete paving, a survey of which disclosed gravel supplies and the inauguration of the patrol system.

The fourth article in the series will appear in next week's issue.—EDITOR.

Nebraska's Practice

NEBRASKA expects to grade 2,000 mi. of earth road in 1920. This is perhaps a greater mileage than any other major earth road building state will complete. To the road builder, however, the year's highway operations are less interesting because of the mileages involved than for (1) the intensive use of machines for both grading and maintenance; (2) the successful employment of dragline excavators for making long, low fills particularly in wet locations, and (3) the general substitution of tractors for horses to operate equipment. It would not be greatly in error to name Nebraska the tractor road building state.

Practically all the highway activity of 1920 is the outcome of enabling laws scarcely three years old. In 1918 major acts were passed: (1) to create a state highway system, (2) to increase automobile license fees to provide a maintenance fund, and (3) to levy a three-mill tax to meet Federal aid funds for road construction. Patrol maintenance was inaugurated in 1920 and 1920 witnesses the beginning of construction on a large scale. This year, therefore, records Nebraska among the large road building states and also gives it exceptional rank in the technics of road construction.

Grading methods and equipment as an engineering study are reviewed by State Engineer G. E. Johnson in an article prepared for a future issue of *Engineering News-Record*. The conclusions of this article will not be anticipated here, but readers are urged to observe two of the features which it will emphasize (1) tractor operation of elevating and wheel graders and 5 cu.yd. fresno scrapers, and (2) dragline construction of long fills. Field observation of both operations tempts one into unstinted praise of their effectiveness.

A study of the records of patrol maintenance of earth roads has developed interesting comparisons of team, tractor and truck patrol maintenance costs. Briefly, experience indicates that the costs of team and tractor patrol for equal sections are about equal and that truck patrol is perhaps most economical. Patrol maintenance began April 1, 1920, and the records for April, May and June, three months, are the basis for comparison.

Team patrol requires one man who furnishes his own team and equipment and who is paid an average of $175 a month. The equipment employed consists of one 6-ft. wheel grader, one farm wagon, one planer, one scraper or fresno, one plow and small tools. The average team patrol section is six miles. Ten team patrols for a three months' period cost $6,493.26, or the

cost of one patrol for one day was $8.32 and per mile per day was $1.38.

Tractor patrol requires two men. It is employed only in counties which had the equipment on hand or which preferred it to other methods. The equipment consists of two maintainers, two small tractors, one plow, one Wisconsin planer, one buck scraper and small tools. Plus depreciation on equipment, the cost of five tractor patrols working 14-mi. sections for three months was $7,532.15, or the cost of one patrol per day was $19.31 and per mile per day was $1.38.

Truck patrol requires two men who are paid $120 a month. Gas and oil are supplied by the county boards. The trucks are part of the surplus war material donated to the State and their price to the counties has been the freight and overhauling charges, which have averaged about $1,000, but which haved varied according to the type of body. New trucks would have cost from $3,500 to $5,000, which would increase the maintenance costs cited here. For truck patrol the equipment consists of one truck, one scraper, one maintainer, two planers, one plow and small tools. Plus depreciation on equipment the cost of eleven truck patrols working 17-mi. sections for three months was $13,692.64 or $15.96 for one patrol per day and $0.94 for one patrol per mile per day.

On an equal mileage basis of 14 mi., 2½ team patrols equal one tractor patrol and the daily cost ($8.32) of one team patrol multiplied by 2½ equals $19.41, while the daily cost of the tractor patrol is $19.31. Truck patrol is altogether more economical than either team or tractor patrol. It is assumed in this comparison that equal amounts of work are accomplished. Also no differences of soil or weather are taken into account. In all cases, however, the costs per mile per day do not mean that one mile was patrolled but once, but as many times as was necessary, and the counties selected for comparison represent average conditions and kinds of work. Incidentally, experience has shown (1) that cost of maintenance decreases if the road is kept constantly in good condition, and (2) that with truck patrol a jointed wheel maintainer will perform 90 per cent of the work.

Concrete Construction

Concrete road construction has been purposely kept to a small mileage because of high costs and shortage of materials. A development of significance, however, has been the use of Platte River gravel as aggregate for a section of about ten miles on the Lincoln Highway. Previously this gravel has been held of doubtful quality for concrete, but tests made by the U. S. Bureau of Roads were sufficiently favorable to encourage its trial on the project mentioned. If the trial proves a success it will establish the only available gravel deposits, which are in the stream beds, as suitable supplies for concrete road materials, and will have a great influence on the state's hard surface road program.

The river deposits are suitable for gravel surfacing, but except for narrow zones along the streams, railway transportation is necessary. On some of the gravel road work performed this year a variation from the usual surfacing practice has been inaugurated: (1) a 2-in. layer is first spread on the earth grade and allowed to rut in and become thoroughly compacted with the subgrade soil and then (2) a second 2-in. layer is applied and consolidated by travel while it is kept smooth by persistent dragging. Since the gravel used has an oxide of iron and clay content, the surfacing is more of the nature of constructing a cemented earth and gravel surface shell to an earth road than it is of the nature of ordinary gravel surfacing.

This gravel surface construction; the probability that local river gravels may be used for concrete; the excellent economic results of truck patrol maintenance; the wide adoption of tractors to operate grading equipment, and the demonstration of dragline excavators as successful earth grading tools, are the outstanding impressions of 1920 highway practice in Nebraska.

Iowa's Practice

Iowa in 1920 inaugurated hard surface construction on its primary road system. Despite its large earth road grading and gravel surfacing program, a continuation of several year's practice, it is this hard surfacing which commands notice principally (1) because about one-third of the counties in the state have voted to hard-surface their mileages of the primary system (in Iowa the counties initiate all construction) and (2) because scientific investigation is making possible, in a state presumably deficient in suitable aggregates, the construction of concrete roads of local gravels. No development in highway practice in 1920 surpasses in importance the experiments and practice in using pit-run gravel for concrete pavements.

Without developing the argument completely, practice in Iowa in respect to materials for concrete roads may be said to be based on the following thoughts: (1) Equal quality concrete and not fixed ratios of cement, sand and gravel is fundamental; (2) so far as practicable roads should be constructed of the materials which are locally available; (3) a sieve analysis of aggregates affords a means of comparing the concrete-making qualities of different materials; (4) an aggregate need not conform to a single grading, instead aggregates of many different gradings will make concrete of equal strength; (5) notwithstanding variability of deposit there is no insuperable obstacle to the use of pit run gravel. As to this last, it is only necessary that the inspection be frequent enough so that the proportions can be changed to suit the variations in the material and that the material conform to accepted standards in other respects.

Aggregate Tests

Upon the reasoning indicated pit-run gravel is being used this year, so far as observation goes, with success. In the way of determining results, besides the usual inspection and observation, tests are being undertaken (1) to determine the actual grading of aggregates in the mixed concrete, (2) to determine resistance to wear and (3) to determine crushing strength. At intervals, as the paving progresses, samples are taken from the mixer discharge, one for immediate washing, drying and screening and two from which the abrasion cylinders and crushing test cubes are molded to be tested in the laboratory this winter. The results of these tests will be given in a special article in a future issue of *Engineering News-Record*. So far as the grading analyses indicate, hardly better proportions could have been secured by screening and remixing the gravel. Should it happen, as is expected, that the

wearing and crushing tests prove satisfactory, the concrete specifications for future road work are quite likely to be made very broad in respect to the use of pit-run gravel.

Material Surveys

Materials surveys conducted persistently have disclosed a greater supply of gravels usable for concrete than, generally speaking, it had been assumed were available. This year the surveys have been conducted primarily in those counties where it was known that hard surfacing projects were to be undertaken, but ultimately they will have covered the state. A chief of party using the records of the state geological survey of 1913 and local information spots the possible deposits in reconnoisance. His assistants then carry out the investigation. The areas located are divided into 200-ft. squares; pits are dug at the corners and the material is tested by sieving for mineralogical character, silt content, etc. Where investgiation is to be carried to greater depths than pits can readily be dug with shovels, or in wet ground, very successful use has been made of a small orange-peel bucket, working inside a 10-in. casing which is carried down with the hole. A small folding derrick is used with this outfit, but the bucket is operated by hand. A light truck moves the gang and its outfit from place to place.

From the materials surveys made the indications are that local supplies of gravel ample for the highway construction of several years to come will be disclosed. Generally the counties have purchased these deposits which it was decided to develop, although a few have been leased. Purchase prices have run from $160 to $2,000 an acre but the average price is from $300 to $500 an acre. Lease prices average between 20c. and 30c. a cubic yard. Some tendency of landowners to profiteer has been experienced, but the state's power to condemn gravel deposits for highway work has discouraged excessive asking prices. Probably 75 county-owned gravel pits are now being operated and this number will be increased greatly as the hard surfacing program develops.

A survey of the concrete paving in progress presents examples of about all the usual methods, but generally they are (1) central proportioning and dry batch hauling (a) by industrial railway and (b) by motor trucks, or (2) central mixing plant and wet batch haulage by motor trucks. This season, as it was desired to encourage contractors to take up paving work, stock piling on the grade, while it was not encouraged, was not prohibited. Only two or three contractors chose this method and it is quite probable that in future work the specifications may prohibit it. Haulage practice presents little that is unusual; one contractor is using two Lee dump bodies instead of one on large trucks and one has hauled wet batches 5½ mi. for concrete base for brick pavement. Generally speaking, the central mixing plant and wet batch haulage method is gaining favor both with contractors and with highway officials.

Progress

Altogether about 150 mi. of paving has been placed under contract for completion in 1920. Of this mileage perhaps one-third will be completed. The major reason for the slow progress has been shortage of transportation. It has not been possible to secure deliveries either of materials or of equipment. On some contracts it has been impossible to start construction. With the purpose of giving contractors all the time practicable to prepare for operation contracts for 1921 construction are now being awarded and will continue to be put up for bids. As a rule, bidders have not been lacking for all the contracts offered. Lack of transportation has not affected grading and this year, as have many years past, will see completed a substantial mileage of earth grade. Only one variation from former practice calls for attention. In one county the state, as an experiment to determine costs, undertook, in 1919 and 1920, force account work with leased equipment. The results indicated no material saving from contract prices.

Prices for highway work, using mileages and quantities as of about September, have averaged for: 357 mi., or 2,998,700 cu.yd. of earth excavation, 57c. a cubic yard; 57.06 mi., or 339,657 cu.yd. of earth excavation incidental to paving, $1.22 a cubic yard; 115.81 mi., or 1,241,015 sq.yd. of concrete paving, $3,988 a square yard; 17.24 mi. brick on concrete paving, or 180,950 sq.yd., $5,665 a square yard; 144 mi., or 206,447 cu.yd. of gravel surfacing, 89.1c. for one-mile haul and 24.75c. for each additional one-half mile haul.

Beginning July 1, Iowa placed its entire primary road system of 6,400 mi. under patrol maintenance. This action, with the experiments previously described in using pit-run gravel for concrete paving, are the outstanding developments in 1920 in highway practice.

Sanitary District Proposed To Regulate Mahoning River

An elaborate storage project for increasing the low-water flow of the Mahoning River above Warren and Youngstown, Ohio, is proposed in a report just rendered to the authorities of Warren by Alexander Potter, consulting engineer. The plan is intended to utilize all the water resources of the valley. At present the low-water flow is far below that required to meet the needs of the numerous industrial plants in the valley without excessive pollution and increase of temperature tending to make the water unfit for the city supply of Youngstown. The latter city built a storage dam at Milton some years ago, by which the low-water flow is considerably increased, but the present project contemplates a large increase of storage.

Three reservoirs are now proposed, one above the Milton dam at Berlin, of five billion gallons capacity, and two others of seven billion and fifty billion gallons on Eagle Creek and Mosquito Creek, below Milton. The two latter would be connected by a canal with the drainage area tributary to the Milton dam. Together the reservoirs would store the flow of the entire Mahoning watershed of about 700 sq.mi., and would make it possible to obtain a summer minimum flow six times as great as the present minimum.

The city council of Warren approved the plan and instructed the officials to petition the Common Pleas Court for the formation of a sanitary district under the Davis law passed by the State Legislature last year. The district would comprise Trumbull and Mahoning Counties. After the formation of the district commissioners representing the counties would decide on and carry out the construction plans. The project as now proposed is estimated to cost $13,000,000 to $14,000,000.

Impressions Here and There

BUTTE—AND A WELDED-STEEL WATER LINE

BUTTE looks like a country God forgot. From the time that the big electric locomotives back the Milwaukee's yellow cars down the Y into the station until their twins slide you gently through the pass toward Anaconda there is no sign of natural beauty except the snowcaps of the continental divide that rise bowl-like some three or four thousand feet above the city. They, at least, have been undisturbed, but everywhere else on what the Butte people like to call "the richest hill in the world" are the evidences of what lies underground. For if God did forget the surface here He provided magnificently below. No place or man can have everything.

Not so many years ago Butte was only one of the many passes—perhaps the lowest—through the Rockies. Then a stray prospector found gold and it became a mining camp. Today it is nothing more. But the gold has long since been taken out and soon the silver, which was found not long after, became unprofitable, but the later and richer discovery of copper and zinc made it what it is today. For a time it was even more desolate than now because of the smelters that ruined vegetation and dropped a perpetual haze over the town, but all but one of them have now moved to Anaconda, some twenty-five miles away, and the air is reasonably clear and a plot of grass or a flower are no longer expensive curiosities. The tailings from the old smelters spread everywhere, however, and the ore dumps and trestles and head frames hang out over the city—a constant reminder of the reason for its existence. Butte is utility personified. Probably it will never be anything else.

Just now the city is in a mild slump. It is probably the only place of its size where there are "To Let" signs. Its most boastful citizens do not claim over 75,000 population for a city which once housed 50,000 more. Copper production is on about half-time and copper is Butte's life. Some day copper is coming back and then if the "Wobblies"—what we in the East know as the I. W. W.'s—can be kept down Butte will come back. Meanwhile, production being low, labor is quiet and the labor element was decisively beaten at the polls this year.

There are no civil engineers to speak of at Butte. Outside of the water company and the Montana Power Company there is no civil engineering to be done. What civil engineers there are are masquerading as mining or metallurgical men and from the looks of the main footbridge leading to the big smelter at Anaconda—a nice wood truss with no sign of post or diagonal, a perfect tribute to the efficiency of the arch—there are few of the metallurgical men with structural training.

A trip through one of the deep mines, though, leaves a civil engineer with a great admiration for his mining brethren. The problems of tunneling and shaft sinking the construction man meets are trivial compared to those encountered in dropping a hole 2,500 ft. into solid granite and feeding up through that hole the precious content of narrow veins that slope and twist through all the intervening space over an area of many acres.

One good engineering job is under way. This is the construction of a 30-mile pipe line from the Big Hole River over the divide into Butte. One such line delivering 8,000,000 gal. a day has been built for a number of years, but the tremendous demand of the mining companies requires a duplicate, making 16,000,000 gal. per day, which would be a very high per capita for the population except for the mining use. The old line is of wood-stave and iron pipe and is standing up very well after over 20 years' use. The new line, which is being built under the direction of Eugene Carroll, who has been with this company for nearly 30 years and is now vice-president, as well as chief engineer, will be of wood-stave where the head is under 300 ft. and of welded-steel pipe in the other sections, where the head runs up to 860 ft.

This welded pipe is a new idea of Mr. Carroll's, for it will have no expansion points except at the occasional valve where a sleeve with lead joints is used. About 10 miles of this line is in the steel pipe, half of it 24-in. and half 26-in. Of the 20 miles of wood-stave about 13 miles is 24-in. and 7 miles 26-in.

The steel pipe comes in 19-ft. lengths and is welded alongside of the 4-ft. deep trench—which goes up and down hill with transit-like directness—into a length of seven sections. Gas-flame welding is used and the pipe turned over on blocking so that the welder is always working on top. When the 133-ft. length is complete the whole section is rolled over on a runway to beams straddling the trench and this near end welded to a similar length already in place. Meanwhile back up the line rope slings have been thrown under the pipe at intervals and the whole snake-like structure is eased down into its bed in the trench at such a progressive rate as always to keep the line on an easy slope from the completed pipe in the trench bottom to the newly placed section on the straddling timbers. Thus the strain on the joints due to bending is kept at a minimum.

Work on the 60-mile line is practically completed and the dirt fill placed over all but a short stretch inside the city. It is Mr. Carroll's idea that the temperature in the pipe will be kept nearly uniform—certainly with no more than 50-deg. variation—by the equable temperature of the water and the 4-ft. topping of earth, and that the expansion stresses will be negligible. It is original engineering in a country where the civil engineer is in the decided minority.

One comes away from Butte with an intense admiration for the men who are doing things there. It is such a bare, hopeless sort of country. But the enthusiasm for the job is much smaller in many a more prepossessing place. The engineering spirit, which delights in surmounting natural odds, is strong there and it prevails.

Butte, Nov. 8.

Decrease in Detroit Labor Employed

According to a labor barometer maintained by the Detroit Employers' Association, a net decrease of 4,440 men was noted for the week ending Oct. 26. The aggregate working force of the seventy-nine firms reported upon was, at that time, 151,141 men. Thirty-five shops were working short hours, employing 32,915 men averaging 39.44 hours per week per man.

Single Track Cut-Off for Double Tracking Main Line

Old and New Lines Equally Favorable for Traffic in Opposite Directions—Heavy Rock Work in Hilly Country

IN DOUBLE-TRACKING its main line between Sleeper and Lebanon, Mo., the St. Louis-San Francisco Ry., is building a single track cut-off about eight miles in length for eastbound traffic, as the present single-track line is favorable to the lighter westbound traffic. The maximum distance between the old and new lines is about 5,000 ft., as shown in the accompanying plan and profile. This single track diversion may be compared with the double-track diversion of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Zionville, Ind., where a five-mile double-track cut-off has been built to eliminate an unfavorable section of the old single track line, as described in *Engineering News-Record* of Sept. 23, 1920, p. 606.

Lighter curves and less total curvature, with a slight saving in distance and also a saving in rise and fall are accomplished by the new location. A comparison of the two lines is shown in the accompanying table. Grades are compensated at the rate of 0.04 per cent per degree of curve. All curves have transition spirals laid out on the Talbot system.

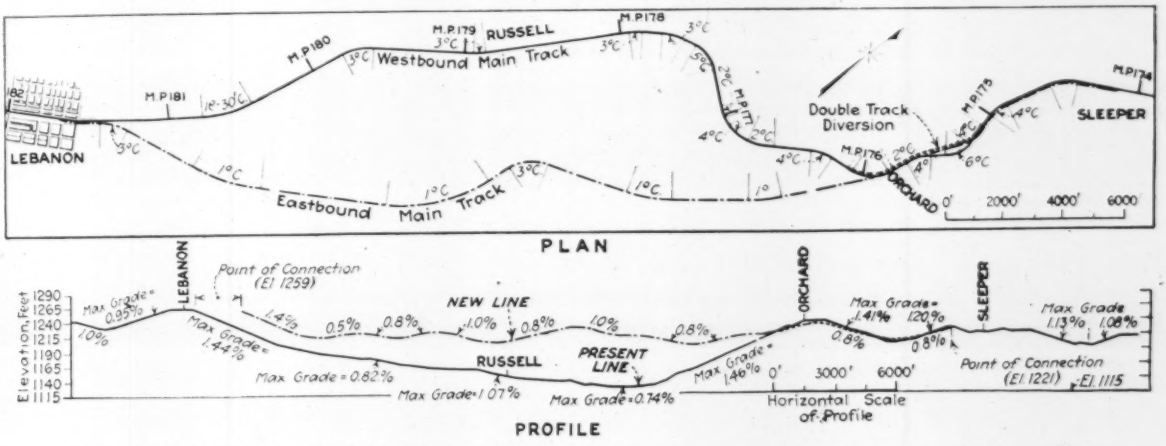
COMPARISON OF OLD AND NEW LINES

	Old Line	New Line	Saving
Distance, miles	7.53	7.08	0.45
Maximum curve	6 deg.	4 deg.	2 deg.
Total curvature	496° 59′	316° 40′	180° 19′
Maximum opposing grade	1.46%	0.8%	....
Rise and fall, feet	134	62	72

This improvement is part of a general program of double-tracking the main line from St. Louis to Monett, Mo., 283 miles. It has been put under construction in advance of other work partly on account of the grade limitation noted above, but mainly for the reason that present operation requires the passing of many trains at or between the stations of Sleeper and Lebanon. For this reason, a 7-mile stretch of double-tracking has also been undertaken between Eureka and Pacific, Mo. In the first part of the new work from Sleeper there is a short double-track diversion which will replace a 6-deg. curve with a 4-deg. curve and will reduce the present grade of 1.41 per cent to 0.8 per cent in both directions.

Higher elevation for the new line is obtained by a location through the higher rough country, the old line following down the valley of a creek for a distance of four miles north of Lebanon and then climbing up on the ridge at Sleeper by a grade of 1.46 per cent. The general topography of the country is hilly, with about 50 per cent under cultivation and the remainder wooded. A limestone formation underlies a cover of 4 to 10 ft. of loose rock and earth.

Grading for the new line will average 30,000 cu.yd. per mile, in alternating cuts and fills, the heavier cuts being about 35 ft. deep and the largest fills 25 ft. high. Two steam shovels at opposite ends of the line are at work in the heavier cuts, and the lighter cuts are being handled by teams and scrapers. Steam-shovel fills are made by dumping from pole trestles built of local timber, about 9,000 lin.ft. of this trestle work being required. Material is handled in 4-yd. dump cars on narrow gage track, trains of 12 to 15 cars being handled by 18½-ton locomotives. All openings are of permanent construction, including eight concrete arch culverts of 8 to 20 ft. span and 19 culverts of reinforced concrete pipe from 18 to 36 in. in diameter.



CUT-OFF FIVE THOUSAND FEET LONG BEING CONSTRUCTED IN CONNECTION WITH DOUBLE-TRACKING ON ST. LOUIS-SAN FRANCISCO RAILWAY

The work will cost about $460,000 and is to be completed in the spring of 1921. The contract has been let to Scott & White, St. Louis, Mo. The construction is in charge of R. Owen, resident engineer, under the direction of F. G. Jonah, chief engineer, St. Louis-San Francisco Ry.

Temperature Effects on White Metals

In experiments on various white metals for bearings, made at the Bureau of Standards recently, it was found that tin-base alloys maintain their strength properties better at elevated temperatures than do those containing lead. However, the yield point or ultimate strength of a high grade babbit at either 25° or 75° C. is not affected by lead admixtures up to 3 per cent. Prolonged heating lowers the strength of lead-base alloys much more seriously than it does that of tin-base alloys. The yield point of a tin-base alloy was not affected by heating for six weeks at about 100° C., but the yield point of a lead-base alloy was lowered by only two weeks' heating at the same temperature.

The Hydraulic Jump and Critical Depth in the Design of Hydraulic Structures

How Established Principles May Be Applied to the Design of Canals and Other Works—A Study Based on the Laws of Conservation of Energy and of Linear Momentum

By Julian Hinds
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THE hydraulic jump and the critical depth have recently come to be recognized as factors of considerable importance in the design of open channels and related hydraulic structures. An excellent technical discussion of this subject will be found in the *Transactions* of the American Society of Civil Engineers, Vol. LXXX, p. 338, in a paper on "The Hydraulic Jump in Open Channel Flow," by Karl R. Kennison, with discussions by a number of prominent engineers. Also, Messrs. Ward, Riegel and Beebe in "Technical Reports, Part III," issued by the Miami Conservancy District, in 1917, present an interesting discussion of the problem, and submit valuable experimental data on the action of the jump below reservoir outlet works. E. W. Lane, in *Proceedings* of the American Society of Civil Engineers, December, 1919, discusses the occurrence of the hydraulic jump in connection with experimental work on flow through contractions.

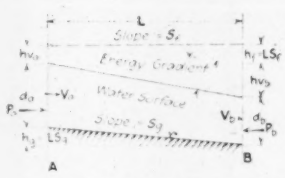


FIG. 1. STEADY FLOW WITH CHANGING VELOCITY, UNIFORM CHANNEL

It is not the intention of this paper to add to the fundamental theories already advanced, but an attempt will be made to show how the established principles may be applied to the design of canals and canal structures.

It is assumed throughout this discussion that the kinetic head is truly represented by the velocity head as computed from the mean velocity.

Practically all formulas previously proposed for the solution of hydraulic jump problems are limited to rectangular sections. While such a limitation simplifies the computations it in no way simplifies the fundamental conceptions, and an attempt will be made to keep the discussion general.

The notation used herein is as follows:

A = Area of water prism = $f(d)$.
b = Width of rectangular channel.
d = Depth of water in any channel.
d_1, d_2, d_a, etc. = Depth of water at Stations 1, 2, A, etc.
d_c = Critical depth.
F = Force producing change in momentum.
$f(d)$ = A = Area of water prism.
$f'(d)$ = T = First derivative of A with respect to d.
g = Acceleration of gravity.
H = Energy of flow = $d + hv$.
h_f = Fall in energy gradient = friction (or other) loss.
h_g = Fall in bottom of channel.
hv = Velocity head.
hv_1, hv_a, hv_b, etc. = Velocity heads at Stations 1, A, B, etc.
hv_c = Velocity head for critical velocity.
L = Distance between consecutive stations.
M = Mass.
P = Hydrostatic pressure on vertical plane across the water prism, the unit force being the weight of a cubic unit of water.
P_1, P_2, P_a, etc. = Values of P at Stations 1, 2, A, etc.
Q = Discharge in cubic units per second.
S_f = Slope of energy gradient.
S_g = Slope of canal bottom.
T = Width of channel at water surface.
t = Time interval.
V = Velocity.
V_1, V_2, V_a, V_b, etc. = Velocities at Stations 1, 2, A, B, etc.
V_c = Critical velocity.
W = Weight of a cubic unit of water.
X = Ratio of T to d for a triangular channel.

As a fundamental basis for discussion it will be necessary to accept the law of the conservation of energy and the law of the conservation of linear momentum. The former law will appear as Bernoulli's theorem, i.e., the elevation of the water surface at any point in a channel plus the velocity head at that point is equal to the same functions at any other point, plus (or minus) intervening losses. Using the notation already given and as shown in Fig. 1 and taking the bottom of the canal at B as datum, this relation may be expressed thus:

$$h_g + d_a + hv_a = d_b + hv_b + h_f \qquad (1)$$

There is no exception to this rule and it is independent of the form or slope of channel, or of channel changes occurring between the two points.

The second law requires that the momentum of a system of particles, considered collectively, cannot be altered by the particles impinging upon each other, but can only be changed by the influence of an external force. The change produced in momentum depends upon the magnitude of the external force and its duration. Stated simply, the law requires that force must equal rate of change of momentum or that force is equal to mass times acceleration. If the acceleration between two stations as A and B, Fig. 1, be uniform, the relation may be written

$$F = \frac{MV_b - MV_a}{t} \qquad (2)$$

where F equals force, MV_a and MV_b are the momentum at A and B respectively and t is the time through which F is applied. If F' is the force acting on a unit volume of water, of weight W, then from equation (2)

$$F' = \frac{W}{gt}(V_b - V_a) \qquad (3)$$

The total force acting on Q units per second for time t will be

$$F = F'Qt = \frac{QW}{g}(V_b - V_a) \qquad (4)$$

Fig. 2 shows graphically the relation existing between the energy of flow (depth plus velocity head), the momentum and the depth for a given discharge in a given channel. This diagram is not affected by the slope or roughness of the channel, and is independent of the method of producing or maintaining flow. The diagram is constructed to scale for 150 sec.-ft. flowing in the irregular channel shown in Fig. 3. The lower of the two curves is obtained by platting values of $d + hv$ over corresponding values of d, and may be called the energy curve, since it represents the energy of flow corresponding to various depths, the bottom of the canal being taken as datum. Values of V and hv may be found for any depth by computing or planimeter-

ing the area. It will be observed that there is one point, C, on the curve for which the value of $d + hv$ is a minimum. The depth, d_c, corresponding to this point is called the critical depth. If flow is taking place at any depth, d_o, other than d_c, there will be a corresponding depth, d_g, having the same value of $d + hv$. The depths d_o and d_g will be called alternative energy depths or alternative energy stages.

Let Fig. 4 represent the profile of a portion of a channel of uniform cross-section having functions as represented in Fig. 2. Then from the energy curve, Fig. 2, it appears that the depth at S may be either d_o or d_g and that it may be made to change from one of these depths to the other at will, provided some means for making the change without depressing the energy line through the point C be supplied.

Such a change in depth with no loss of energy, however, involves a change in momentum and can only be

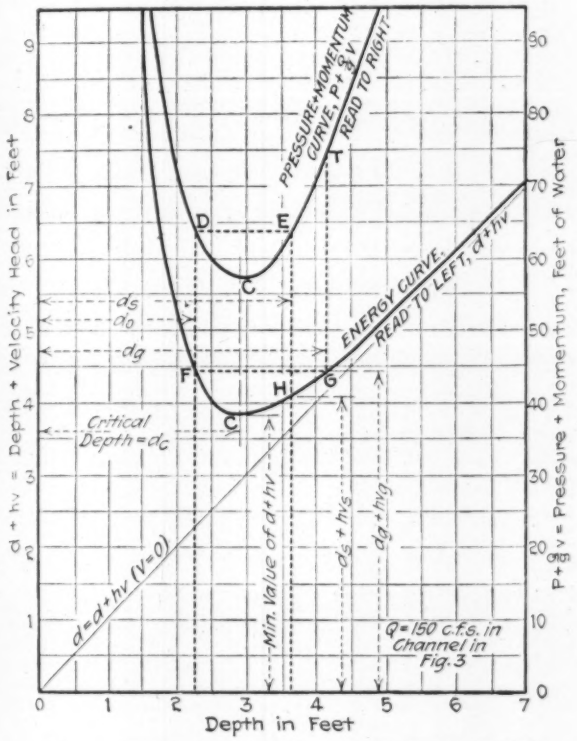


FIG. 2. RELATION BETWEEN ENERGY OF FLOW, MOMENTUM AND DISCHARGE

effected by the intervention of some external force. The required force may be supplied by gravity, friction, unbalanced pressures or by a combination of these factors.

In Fig. 1, let P_a be the hydrostatic pressure on the plane of the cross-section at A, P_b being the corresponding pressure at B, and let F''' equal friction, or any other external force applied between A and B. From (4), taking $W = 1$

$$\frac{Q}{g}(V_b - V_a) = P_a - P_b \pm F''' \qquad (5)$$

If the change in depth occur without the intervention of the force F''', then equation (5) placing $F''' = o$ and transposing gives the relation

$$\frac{Q}{g}V_a + P_a = \frac{Q}{g}V_b + P_b \qquad (6)$$

which must hold if a change in depth occurs under the influence of the external forces P_a and P_b only.

The momentum curve in Fig. 2 gives values $\frac{Q}{g}V + P$ for various values of d. The abscissæ are the same as used for the energy curve and values $\frac{Q}{g}V + P$ are shown on the right. For a given depth there is always one other depth having an equal value of $\frac{Q}{g}V + P$, this point falling in all cases beyond the critical depth. Therefore, for any depth of flow there is always another depth which we will call the alternative momentum stage, to which the flow may change without the intervention of an external force. Such a change, however, requires a change in the energy of flow.

Since for a given change in depth the change in $d + hv$ is not proportional to the change in $\frac{Q}{g}V + P$ it follows that a change in depth cannot occur without the introduction of some factor to preserve a balance. A change between alternative energy stages without loss may be effected by the application of an external force only, and a change between alternative momentum stages may be accomplished by a change in energy only. All other changes in depth, involving a change in velocity, require both an external force and a change in energy.

There are numerous causes which may produce a change in stage in a canal, but if the channel is straight, of uniform cross-section and roughness, and free from obstructions, changes in stage are generally caused by changes in grade. An analysis of a simple case will be made to show where changes may be expected. Let Fig. 5 be the profile of a canal of uniform cross-section. Let the slopes to the left of K and to the right of N be sufficient to maintain flow at normal depths, d_i and d_s, respectively, both greater than the critical depth, the slope between K and N being sufficient to maintain a normal depth, d_m, less than the critical. Let I be a sufficient distance upstream from K not to be affected by the "drawdown," and let M be sufficiently far below K for uniform flow to be established. Flow at I will be at high stage while at M it will be at low stage. Somewhere between it must pass through the critical depth.

Before proceeding to locate the point of passage it will be well to investigate the properties of the "energy gradient" shown on the profile. This gradient is determined by plotting the velocity head above the water surface at all points. At a given point the total energy, i.e., the sum of the static and kinetic energies, is represented by the elevation of this line. It follows from Bernoulli's theorem that the fall in this gradient between any two points represents the sum of all losses occurring between the two points. The slope of this line at any point represents the slope required to overcome friction and other losses at that point. The energy gradient can never rise in absolute elevation in the direction of flow, since there can be no increase in energy. The distance from any point on the energy gradient vertically downward to the bottom of the canal is $d + hv$. It will be clear from Fig. 2 that there will in all cases be two water depths corresponding to

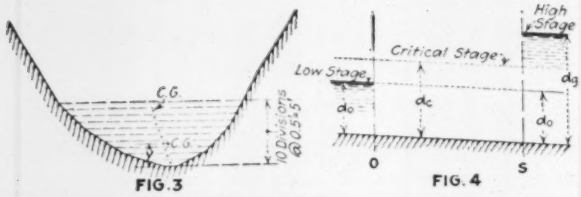


FIG. 3 FIG. 4

FIG. 3. SHOWING SUBDIVISIONS FOR COMPUTING AREAS AND PRESSURES. FIG. 4. ALTERNATE STAGES

any possible energy gradient. It is also evident that the energy gradient cannot be brought to within less than a certain minimum distance from the bottom of the canal, the two corresponding depths becoming equal at that point. The gradient will generally be a continuous line and can make an abrupt change in height or slope only where a sudden loss occurs. An example of sudden loss, caused by an abrupt change in stage, is shown at *O*, Fig. 5. So-called sudden changes in open channels are actually more or less extended, but for simplicity they are assumed in all computations to be instantaneous.

Returning to Fig. 5, the water surface must pass through the critical depth between *I* and *K*, at *K* or between *K* and *M*. Assume the passages to occur at some point *J* above *K*. The energy gradient must under this assumption drop down at *J* to a minimum height above the bottom of the channel. Therefore, the friction slope from *J* to *K* cannot be steeper than the slope of the base of the canal, and, since the slope of the canal is only sufficient to maintain flow at the normal depth, d_i, which is greater than the critical depth, the energy available is not sufficient to overcome friction losses from *J* to *K* and maintain flow at or below the critical depth. Hence the critical depth cannot exist at any point above *K*. If the passage occurs at some point, *L*, below *K* the water surface from *K* to *L* must be at or above the critical, the velocity will be less than normal, and therefore the friction slope will be flatter than the canal slope; that is, the value of $d + hv$ at *L* will be greater than at *K*, whereas if the critical depth occurred at *L* it should be less. Therefore, the passage cannot occur below *K*. If the point of passage is at *K*, $d + hv$ will increase from *K* to *M* and the fall in the gradient will be less than the fall in the canal grade. This is logical since the velocity is less than the normal velocity. The fall in the energy gradient from *I* to *K* will be greater than the fall in the canal grade, to balance the increase in friction due to velocities in excess of the normal velocities. The point of critical flow will, therefore, come at *K*.

No reference has been made to values of the slope from *K* to *N* except to state that it is sufficient to maintain flow at a depth less than the critical. As long as this slope is sufficient to support flow at a normal depth equal to or less than the critical depth, it may be varied at will without affecting flow conditions above *K*. For this reason *K* is called a control.

Flow to the right of *M* will be uniform at the depth d_m until the flatter slope at *N* is encountered. For simplicity the loss through shock due to the vertical angle at *N* is neglected. In actual construction this angle, if sharp, would be relieved by a vertical curve to reduce the shock. Flow to the right of *N* cannot continue at the depth d_m, since the slope of the canal is insufficient to overcome friction at that depth. The excess of the frictional resistance over the force due to the slope of the bottom of the channel produces a retarding force tending to reduce the velocity and momentum of flow and causing the depth to gradually increase, the velocity head and the depth plus velocity head being decreased to supply the energy necessary to overcome friction.

If this gradual rise in water surface be assumed to continue, along the dotted line *YZ* in the figure, until the normal depth is reached at *Z*, there will be some point, as at *S*, where the depth is equal to the critical depth. Since $d + hv$ is a minimum at *S* and is not a minimum at *Z* it follows that the available friction slope from *S* to *Z* must be less than the canal slope. But the velocity from *S* to *Z* is greater than the normal velocity, hence the required friction slope is greater

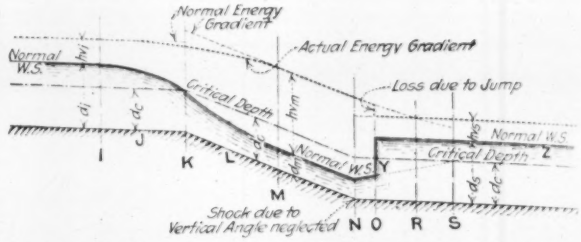


FIG. 5. CHANGES OF STAGE IN UNIFORM CHANNEL

than the canal slope, and the depth cannot change from d_c at *S* to d_s at *Z*. It is necessary that the water depth change, between *N* and *Z*, from d_m to d_s, but it must not at any point have the intermediate depth d_c nor in fact any depth for which $d + hv$ is less than at *Z*. The change occurs suddenly through what is known as the hydraulic jump, from some low-stage depth to the depth d_s. The depth d_s and the low-stage depth at *R*, where the energy gradient for the water surface *YZ* intersects the normal energy gradient, are alternate energy depths, similar to d_g and d_o in Fig. 2, and if the jump involved no loss of energy it would occur at that point. Referring to Fig. 2 it will be seen that in order for the change to occur at *R* there must be an increase in $P + \frac{Q}{g}V$, similar to the change from *D* to *T*. Such a change in momentum requires the application of an external force. The only external forces available aside from P_e and P_f are the forces of gravity acting through the canal slope and resistance due to friction. These tend to neutralize each other and are negligible in amount. Therefore, F'' in equation (5) may be assumed to be zero, equation (6) must hold, and the jump cannot occur at *R*, but must take place at some earlier stage where $P + \frac{Q}{g}V$ is equal to the final value of that function. This requirement apparently conflicts with Bernoulli's theorem, but there is automatically introduced a disturbance which produces an internal loss of proper magnitude to preserve the equilibrium of equation (1). The low-stage depth at the jump will be d_o, corresponding to the point *D* on the momentum curve in Fig. 2. The loss of energy in the jump is equal to $(d_g + hv_g) - (d_s + hv_s)$.

This loss is unavoidable for a change in stage in a channel of constant cross-section and falling grade.

By properly adjusting the shape or vertical alignment of the channel additional external forces may be introduced, and the jump, with the attendant loss of head, may be reduced or eliminated, as will be pointed out later.

The two curves in Fig. 2 approach each other indefinitely to the left of C, while to the right of C they diverge rapidly. A little study of these curves will show that for small heights of jump the loss approaches zero, but that the loss of head increases rapidly as the height of jump increases. For example, in Fig. 2, if the jump occurs from $d = 2.5$ to $d = 3.38$ the loss in depth will be from $d = 3.47$ to $d = 3.38$ or 0.09 ft. The corresponding energy loss is about 0.05 ft. If the jump occurs from $d = 2$ ft. to $d = 4$ ft., the loss in depth will be from 5 ft. to 4 ft. or 1 ft., the energy loss being $5.17 - 4.33 = 0.84$ ft. If the jump occurs from $d = 1.75$ ft. to $d = 4.55$ ft. the loss in depth will be $6.30 - 4.55 = 1.75$ ft. and the energy loss will be $6.40 - 4.80 = 1.60$. Taking the discharge as 150 sec.-ft. this last loss requires the continuous destruction of energy equivalent to about 27 horsepower.

After the depth, d_a, from which the jump will take place has been determined the location of the jump may be obtained by finding the point at which flow will be retarded to that depth. This point may be conveniently found from the following equation, derived from Fig. 1:

$$Ls_g + d_a + hv_a = d_b + hv_b + Ls_f \qquad (7)$$

By assuming values for d_a and d_b all functions at A and B can be computed, including the friction slopes. If the canal slope, s_g, be known and if the friction slope from A to B, be assumed equal to the average of the slopes at these points, all factors in equation (7), except L, become known and L is readily found.

Equation (7) is applicable to any variable flow. The only approximation involved is in the assumption that the average slope is equal to the average of slopes at the computed points. By assuming depths sufficiently close together the error from this source can be reduced as far as desired. However, ordinary friction formulæ are not known to apply accurately to variable flow and extreme refinement in computation is not justified. The friction slope may be determined by Kutter's formula, or by any other friction formula. This equation should not be applied through a control section or a hydraulic jump, but may be used to find the water surface at J, L or N, Fig. 5, or above a check or dam.

The changes in canal slope at points K and N, Fig. 5, are purposely assumed to be great, so that the changes in stage will be marked, but when the normal depth is near the critical, troublesome fluctuations are often produced by very slight unintentional irregularities in the channel. The fluctuations in such cases appear to be out of all proportion to the offending irregularities. This is due to the fact that in the vicinity of C, Fig. 2, the momentum and energy curves are approximately horizontal so that if the amount of energy ($d + hv$) required at a given point is changed slightly, a comparatively great change in depth must occur to preserve a balance. The possibility of trouble from this source is discussed by J. S. Longwell in an article on "Flow Conditions, Congo Low Line Flume, North Platte Project," published in the *Reclamation Record*, August, 1917, and reprinted in *Engineering News-Record*, Jan. 3, 1918, p. 38. If in the design of a channel it is found that the depth is at or near the critical the shape or slope of the channel should, if practicable, be changed to secure greater stability. Usually the critical velocity can be changed by widening or narrowing the channel, or the normal velocity by altering the slope. If such changes are not practicable, liberal freeboard should be allowed, and extreme care should be used in construction to secure uniformity in grade and cross-section.

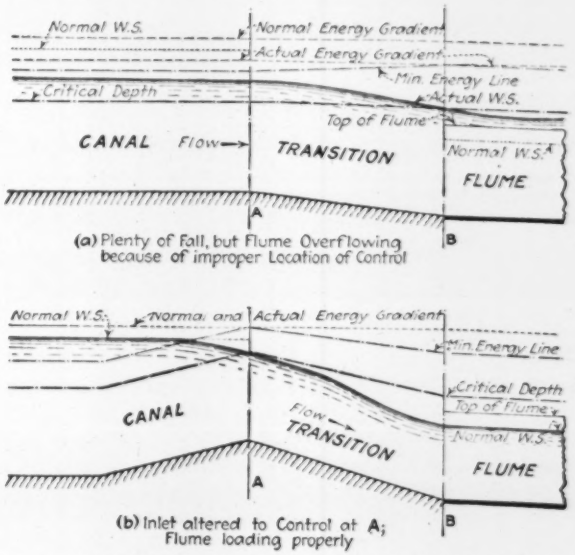


FIG. 6. VARIABLE CROSS-SECTIONS CANAL TO FLUME. FOR TRANSITION FROM HIGH TO LOW STAGE

Changes in stage which occur at transitions between canals and flumes, tunnels or other high-velocity conduits, where the cross-section of the channel is variable, involve only the principles already discussed, but additional factors are introduced which affect the mathematical treatment. It will be convenient to consider these transitions under six headings, as determined by the stages between which changes occur, as follows:

(a) Changing from high stage to low stage, increasing velocity.

(b) Changing from one low stage to another, increasing velocity.

(c) Changing from one high stage to another, increasing velocity.

(d) Changing from low stage to high stage, reducing velocity.

(e) Changing from one low stage to another, reducing velocity.

(f) Changing from one high stage to another, reducing velocity.

Case (a) is similar to the example presented in the discussion of Fig. 5, and by arguments already used it can be shown that the control section cannot be above A or below B, in Fig. 6, AB being a variable transition between a canal and a flume. To locate the point of control plot a minimum energy line, as shown in (a) and (b), Fig. 6. This line is obtained by plotting the minimum values of $d + hv$ above the canal bottom, and it represents the minimum possible elevation of the energy gradient at any point. The actual energy gradient cannot fall below this line and if the two gradients intersect it must be at the highest point on

the minimum line. Hence, in Fig. 6 (a), although there is apparently sufficient drop from the normal water surface in the canal to that in the flume, the flume will overflow because of the incorrect location of the control. The drop which should produce velocity head is used up in friction through the lowering of the water surface in the canal. By humping the bottom, as in (b), to bring the minimum energy line at the upper end of the transition into coincidence with the normal energy gradient, the trouble is avoided. Racing in the canal is prevented by the throttling effect of the control at *A*. The same effect can be secured, if desired, by narrowing the section at *A*, rather than by raising the grade. The inlet structure may be made to act as an automatic check by shaping it so that the head required to pass any quantity of water at the critical depth is equal to the normal head in the canal above for that quantity. It is theoretically possible to construct such a control check so that it will exactly control all quantities of flow in a given channel, but it is sufficient, for all practical purposes, to design the structure to fit exactly for two discharges, usually full discharge and one-fourth discharge, as in the case of a notched drop.

In changing from one low stage to another, having a greater velocity (case b) it is possible, by contracting the channel or by raising the bottom, or both, to force the water surface up to the critical depth and under extreme conditions a jump may be produced within the transition or in the canal above. Such a contingency is, however, remote and ordinarily this type of transition will not be effected by the critical depth or the hydraulic jump.

The transition from one high stage to another, having a higher velocity (case c) is often accompanied by disturbances attributable to an incorrect control. Fig. 7 represents to an exaggerated scale a faulty design recently prepared by the writer for a transition from a segmental open channel to a circular tunnel. The hydraulics for this transition were computed at 2-ft. intervals and no discrepancies were found. However, liberal allowance was made for transitions and friction losses, and a "safe" coefficient of roughness was used to determine the depth in the tunnel. After construction it was found that transition losses were negligible and that the normal depth in the tunnel immediately below the entrance was considerably less than the assumed normal depth. As a result the energy gradient for the tunnel dropped below the summit of the minimum energy line, and the flow passed to low stage at *E*, causing a jump to occur just below the end of the transition. The transition should have been proportioned to keep the summit of the minimum energy line below the lowest possible position of the energy gradient at *F*. The jump was particularly objectionable at this location, and was eliminated by bolting cross timbers to the bottom of the channel, thus increasing the friction and bringing the energy gradient up to its computed position.

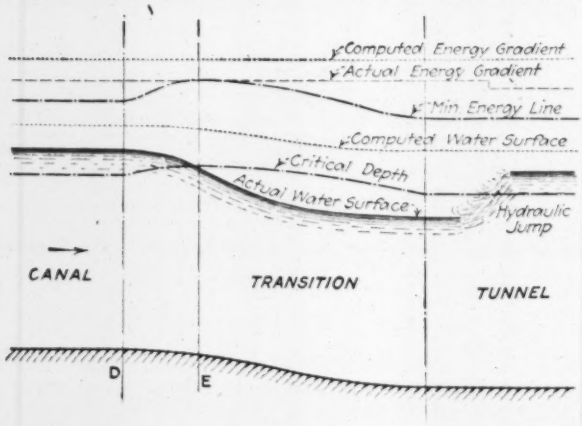


FIG. 7. FAULTY INTAKE—ONE HIGH STAGE TO ANOTHER

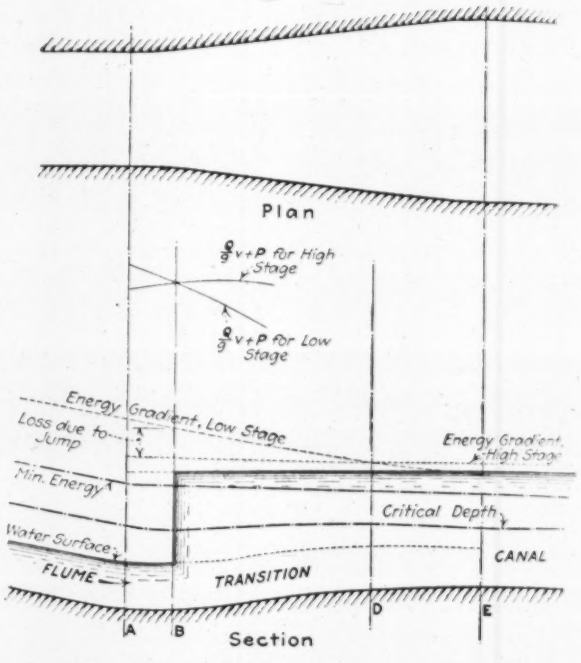


FIG. 8. JUMP, WITH VARYING CHANNEL SECTION AND BOTTOM SLOPE

Transition from low stage to high stage, (case *d*) may be accomplished either with or without the hydraulic jump. Unless the section of the channel is properly varied or the bottom "humped" the jump is inevitable. Fig. 8 represents a transition in which the variation in channel section is not sufficient to avoid the jump. The energy gradient for low stage is computed from *A* toward *E*, using equation (1), the gradient for high stage being computed backwards, from *E* toward *A*, in the same way. After these gradients and their corresponding depths are found values of $\frac{Q}{g}V + P$ for the two stages are computed, and plotted to any convenient scale and datum. The jump must occur where this function is equal for the two depths, or at *B*, the intersection of the plotted lines. By varying the cross-section or the elevations of the flume, transition or canal, the location of the intersection, *B*, may be varied at will. If this point falls to the left of *A* the jump will occur in the flume and may cause it to overflow. If it falls to the right of *E* the jump will occur in the canal section where the resulting disturbances may be objectionable.

If the transition in Fig. 8 be so altered that the minimum energy line at *D* becomes tangent to the two energy gradients at their point of intersection, the two gradients automatically changing to become tangent to

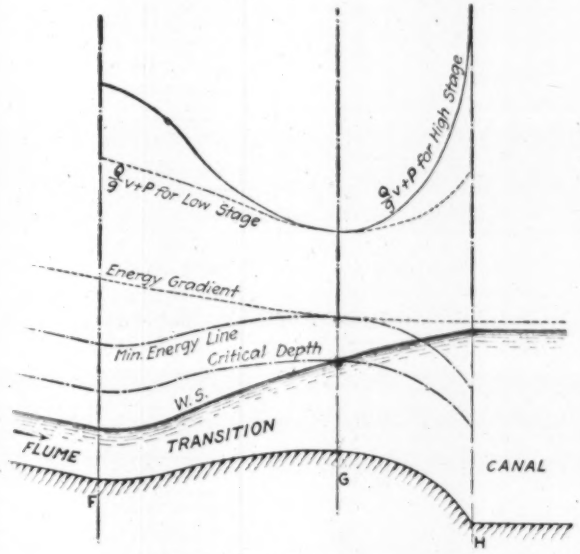


FIG. 9. TRANSITION WITHOUT JUMP

each other at that point, the transition may be accomplished without the jump. Such a transition is illustrated in Fig. 9. The $\frac{Q}{g}V + P$ lines intersect and become tangent at the point G. The excess of the pressure in an upstream direction over that in a downstream direction on the hump in the bottom or on contractions in the sides of the channel supplies the force F'' required in equation (5).

In changing from one low stage to another with a lower velocity (case e) the hydraulic jump and the control section are not often encountered. A contraction in the sides of the channel or a hump or obstruction in the bottom may cause the water surface to rise temporarily above the critical depth, but such contraction or obstruction is not likely to exist in an artificial channel, except by deliberate design. The low secondary dam sometimes placed below an overflow dam to break up the high velocity constitutes such an obstruction, but the normal depth below the secondary dam is usually above the critical so that the conditions of (case d) obtain.

The most usual form of canal transition for reducing velocity is from one high stage to another and such structures are often subject to unexpected irregularities. It is usual in designing transitions of this type to provide for only a partial recovery of head, to allow a factor of safety to take care of imperfections in the structure and of fouling in the canal below. This results in an excess of energy. If the minimum energy line is at all points well below the energy gradient the water surface in the high-velocity channel will be lowered and the excess head will be consumed in increased friction, but if the minimum energy line is high a control is likely to be formed, resulting in low-stage flow for a short distance, followed by a jump back to normal. An actual instance of such an outlet is shown in Fig. 10, where a very gradual change from a 6.1-ft. diameter tunnel to a 8.3-ft. segmental lined section is effected in a length of 100 ft. If the critical depth in the tunnel and in the transition had been lower the water surface would have been further drawn down at J to make the energy gradient from above coincide with that from below, but the high position of the minimum-energy line at J limits the draw down. As a result the flow passes to low stage at J, returning to high stage through the hydraulic jump at K. The location and height of the jump may be determined as in case (d) Fig. 10 is plotted from actual observations. If the required water surface elevation at L were to be increased to bring the energy gradient at that point above the elevation of the minimum-energy line at J, the control at J and the jump at K would be avoided. It will be noticed that the velocities increase from J toward K, reaching a maximum somewhere near K, the effective length of transition being reduced to KL. Under proper conditions the point K may fall to the right of L, and in any event the turbulence below L will be greater than if the transition were effected without the jump. If turbulence is objectionable the outlet should be proportioned to avoid the formation of a control.

The critical depth may be found by constructing either the energy or momentum curve, and finding its lowest point, as in Fig. 2, but it can be more readily determined by means of the equation

$$\frac{A^3}{T} = \frac{Q^2}{g} \qquad (8)$$

where A and T are respectively the area and top width of the water sections for the critical depth. Using

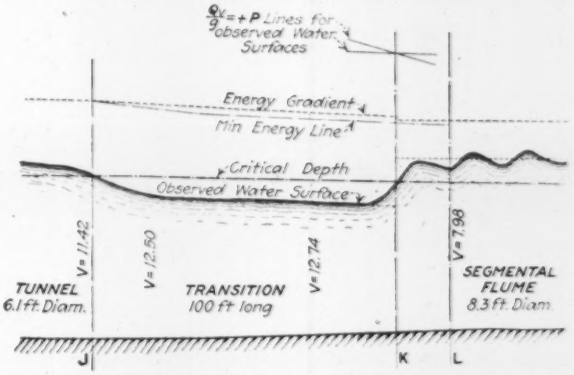


FIG. 10. TRANSITION FROM ONE HIGH STAGE TO ANOTHER; JUMP CAUSED BY EXCESS HEAD

the notation already established, and letting $H = d + hv$, and A = area of section = some function $f(d)$ of the depth, equation (8) is derived as follows:

$$H = d + hv = d + \frac{V^2}{2g}$$

$$= d + \frac{1}{A^2} \times \frac{Q^2}{2g}$$

$$= d + \frac{1}{f^2(d)} \times \frac{Q^2}{2g};$$

differentiating, $\frac{dH}{dd} = 1 - \frac{f'(d)}{f^3(d)} \times \frac{Q^2}{g}$,

where $f^3(d) = A^3$ and $f'(d)$ = the first derivative of A with respect to d, = T, the width at the water surface. H is a minimum when

$\frac{dH}{dd}$ is zero, or when $\frac{A^3}{T} = \frac{Q^2}{g}$ as given above.

By substituting AV for Q this equation may be written

$$\frac{A}{2T} = \frac{V^2}{2g} = hv \qquad (9)$$

In a rectangular section of width, b, A is equal to bd, T is equal to b, and (8) may be reduced to

$$\frac{Q^2}{g} = b^3 d_c^3 \text{ (for rectangular sections)} \qquad (10)$$

from which d_c is readily determined. Equation (9) reduces to the well-known form

$$hv_c = \frac{1}{2} d_c \text{ (for rectangular sections)} \qquad (11)$$

In a triangular section, where the ratio of T to d is X, equation (8) reduces to

$$\frac{Q^2}{g} = \frac{d^5 X^2}{8} \text{ (for triangular section)} \qquad (12)$$

and (11) becomes

$$hv_c = \frac{1}{4} d_c \text{ (for triangular section)} \qquad (13)$$

Similar formulæ may be deduced for any channel having a known mathematical relation betwen A, t and d, but generally the resulting equations are of the $\frac{5}{2}$ deg., and are complicated, and it is preferable to use equations (8) and (9) without further reduction. If d_c is known and Q required these equations may be solved directly, but if d_c is the unknown the solution can best be made by trial.

Valuable assistance in the preparation of this paper has been rendered by D. C. McConaughy and W. H. Nalder and other engineers in the Denver Office of the Reclamation Service.

To Discuss Labor Conditions and Hours of Work in Steel Industry

In order to learn the results of the three-shift system in steel plants Horace B. Drury, formerly of the economics department of *Ohio State University and recently* with the Industrial Relations Division of the Shipping Board, has been spending some months in visiting steel plants in the United States, collecting technical data covering the details of the operation of the system.

Mr. Drury has put the results of his observations into a paper which will be presented at a joint meeting held under the auspices of the Taylor Society in New York, Dec. 3 at 8 p.m., in the Engineering Societies' Building. The other organizations participating in the meeting will be the metropolitan and management sections of the American Society of Mechanical Engineers, and the New York section of the American Institute of Electrical Engineers.

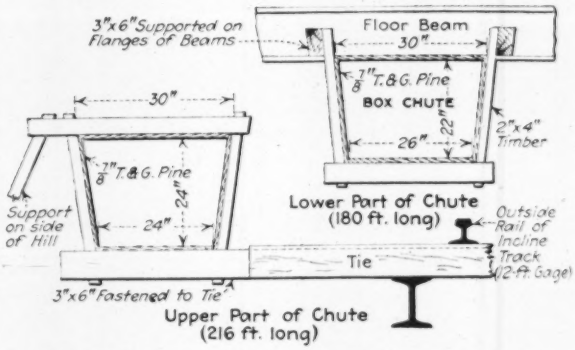
The purpose of presenting the paper is to assist the steel industry in America to prepare for the three-shift system which, judged by the general tendency toward the shortening of hours of labor and the fact that in other countries steel production has been put upon the three-shift basis will probably come here. It is therefore the part of wisdom for managements to prepare for it.

At the same meeting William B. Dickson, vice-president of the Midvale Steel & Ordnance Co., will discuss the subject from the point of view of the manufacturer, and the general discussion will be led by Robert B. Wolf, consulting engineer, New York.

Landslip Material Successfully Chuted Into Railroad Cars

REMOVAL of a hillside slide by passing the material down a steep chute into cars has been carried out successfully on the Pennsylvania System near the Birmingham station at Pittsburgh. At this point the rocky face of the hill rises abruptly from the track level for 150 ft. and then continues on a steep slope for about 200 ft. to the top. During the thaw early this year, springs in the hillside caused a slip near the top, the material blocking two of the four tracks.

Two steam shovels mounted on flat cars were sent to the work, laborers secured by ropes tied to trees being stationed at the top to shovel down the loose earth. After a few days a fire hose was led over from the top and an attempt was made to wash the dirt down



INCLINED CHUTE USED IN CLEARING LANDSLIDE

This proved unsatisfactory, but the steam shovels had cleared the tracks and drying weather had set in, so that there was no immediate danger of further sliding. The engineers in charge of the work finally decided upon a system of removing the loose material by hand and passing it down an inclined chute, a ¾-in. jet of water being used simply as a lubricant. This method proved satisfactory and was carried on during the summer, when conditions were favorable.

The steel inclined structure of the Monongahela Inclined Plane Co. is near the slip and was utilized to support the chute, which was 396 ft. long and had a slope of 1 on 3. The construction is shown in the accompanying drawing. For the upper 216 ft. of the length, timbers 3 x 6-in. were placed in the track of the incline, projecting on one side about 5 ft. beyond the ends of the ties and carrying frames for the box chute. For the lower 180 ft. the chute was suspended beneath the deck of the incline, the frames being spiked to timbers resting on the flanges of the steel floor beams. The chute was a closed box of ¾-in. tongued and grooved flooring, but as this was rough enough to cause clay to adhere to the sides it was afterward lined with sheet iron. With this lining and the lubricating effect of water operation was successful.

Traps or movable doors in the top provided for dumping the material into the chute, twelve men with wheelbarrows being engaged in this work, and loading on an average of two cars daily. These openings were useful also in removing occasional stoppages when the material consisted mainly of clay. At the lower end of the chute a bottom trap delivered the material into the

car. This method was adopted as it avoided any interference with traffic on the four-track main line, the cars being placed on an existing side track. The work was carried out under the direction of C. W. Richey, division engineer, and W. D. Wiggins, chief engineer of maintenance of way, Pennsylvania System, Pittsburgh, Pa.

Notes on the Design and Principles of Sewage Siphons

By Weston Gavett
With Clyde Potts, Civil Engineer, New York City

THE large number of automatic devices of the hydro-pneumatic type that have been produced for sewage disposal plants indicates that many engineers have enjoyed the diversion of working on this interesting subject. At present the manufacturers of patented apparatus seem to have the subject well covered and in most cases are permitted to do all the worrying about design. The article by G. H. Bayles in *Engineering News-Record*, May 13, p. 974, describes an exceptional case where the engineer avoided a delay in the delivery of the apparatus by designing and constructing a timed siphon with no other guide

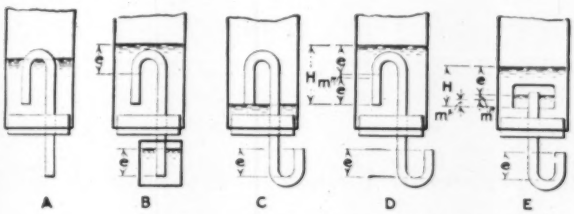


FIG. 1. DEVELOPMENT OF SEWAGE SIPHONS

than a picture of the device. As Mr. Bayles points out, little information is readily available on the design of these devices. An excellent article by E. G. Bradbury appeared in the *Proceedings* of the Ohio Engineering Societies for 1910. A short article in the *Cornell Civil Engineer* of June, 1912, summarized the thesis studies of the writer. The latter, now out of print, discussed the operation of simple siphons, methods of venting, etc. with the results of tests on the hydraulics of small siphons.

Some knowledge of the design and principles of operation of this type of apparatus should be of value to the engineer, first in choosing the type best suited to the work required and later in interpreting any failure in operation. The following notes on the first principles and hydraulics of siphons may be of interest:

Fig. 1 illustrates the elements of the simple siphon. A shows a plain siphon of the form the name suggests. This would function intermittently provided, (a) the inflow is great enough to carry the air from the siphon when the liquid overflows into the long leg and (b) the inflow is small enough to allow the liquid to be drawn to the bottom of the short leg so that venting is obtained. Practically this would not work. What is lacking is a sure and positive means of starting and stopping the flow through the siphon. The early flush tank siphons of the Vibbard, Field-Waring and Van Vranken class are examples of type A with auxiliary devices to give positive operation. If the long leg of the siphon dips in a sump as in type B, the water

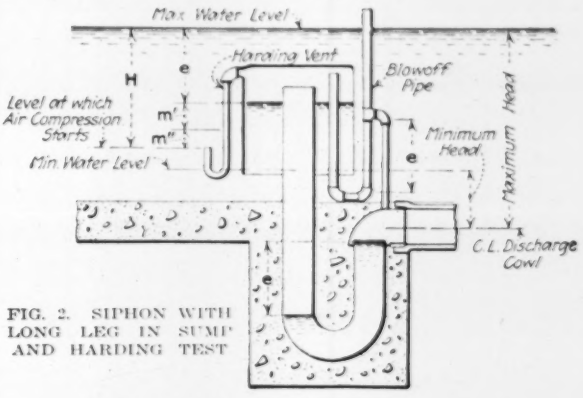


FIG. 2. SIPHON WITH LONG LEG IN SUMP AND HARDING TEST

level in the tank may rise above the top of the siphon before discharge commences. This has the advantage that when the confined air is released, either by blowing out at the bottom of the long leg or by auxiliary blow off, the siphon is under some head and will more surely fill with water and start operating. One form of siphon on the market is of this type, equipped with suitable blow off and vent pipes for starting and breaking the flow. Instead of terminating the long leg in a sump another bend may be used as in C. Substitute a bell for the upper bend and the siphon takes the form used by Mr. Bayles. (E, Fig. 1 and Fig. 2.) Siphon C should work well in starting, at least with small sizes, but difficulty might be expected at the end of discharge in obtaining a thorough venting and return to the original starting condition shown in C.

The discharge head, H, is determined by the length of the lower leg e and with a siphon of the same internal area throughout as D, Fig. 1, $H = 2e + m''$, where m is the rise of water in the upper leg caused by the compression of the trapped air. If the legs are of unequal diameter as with a bell, (E', Fig. 1,),

$$H = e + m' + m'' \text{ where}$$

$$m' = \frac{ea_1}{(A - a_2)} \quad \text{and}$$

m'' = the rise in bell caused by the compression of air,

$$= \frac{V - V''}{(A - a_2)}$$

a_1 = area of inside of pipe
a_2 = area of outside of pipe
A = area inside of bell
V' = volume of enclosed air under atmospheric pressure
V'' = volume of enclosed air under water pressure of head e.

$$V'' = \frac{V' (P_{atmos.})}{(P_{atmos.} + 0.434\, e)}$$

H indicates the distance between the level where air compression starts and the level where discharge commences. It is important to note that with the Harding vent air compression starts at the top of the small pipe, a higher point than the level at end of discharge. (See Fig. 2.)

For dependable operation, auxiliary blow off pipes are needed for large siphons and vent pipes or sniff holes for all sizes. Various types of each are in use.

When an auxiliary blowoff is used, the discharge head is figured from the length, e, of the trap of the blowoff, which is smaller than the length of the main trap. (Fig. 2). This method of starting the siphon has the advantage that the water is suddenly and completely ejected from the small pipe, giving no opportunity for the water to surge and reseal the air outlet before the siphon has started. The same advantage holds for the Harding vent, Fig. 2. As the water in the tanks drops below the top of the small arm of the vent, during the discharge of the siphon, the liquid in the vent drops slightly lower due to the friction loss and velocity head in the siphon. When the lower bend of the vent is reached, the liquid in the vent is suddenly inspirated, giving a clear air passage protected from resealing by the short arm projecting above the liquid in the tank. A further advantage of auxiliary pipes subject to violent expulsion of liquid is in preventing clogging.

In figuring the discharge head of a siphon with auxiliary piping the principle is the same as for a simple siphon but care must be taken to allow for the change of air volume in small piping in computing the factors m' and m''. The article by Mr. Bayles gives an excellent example of the method of determining the discharge head of a siphon with complicated connected piping. The actual discharge head may vary from the computed head by 0.1 ft. or less. With the Harding vent the low water level in the tank is a short distance above the point where venting starts for the reason mentioned above.

Comparative Experiments

Experiments with a 3-in. Miller siphon and 4-in. Merritt siphon demonstrated that the variation in the actual discharge head during repeated tests was less than 0.01 feet.

For the average rate of flow of sewage siphons, Mr. Bradbury gives the formula

$Q = 0.4\ A\ \sqrt{2gh}$, where
Q = rate of flow in cubic feet per second.
A = area of discharge pipe
h = average head = ½ the distance from the center of the discharge pipe to the maximum head.

The 3-in. Miller siphon tested gave the approximate formula

$Q = 0.4\ A\ \sqrt{2gh}$, where
h = (max. h + minimum h) ÷ 2
A = area of siphon pipe.

For the 4-in. Merritt siphon (type B, Fig. 1) an approximate formula for average flow is

$Q = 0.4\ A\ \sqrt{2gh}$, where
h = the average head above the center line of the outlet pipe in sump

The greatest part of the friction loss is caused by the short radius bends. Smaller loss may be expected in types having bends of larger radius.

The equations for flow through the siphons tested gave a straight line relation on logarithmic cross section paper except where modified by suction of air through vent pipes.

3-in. Miller siphon:

$h = 32.0\ Q^{1.95}$
$h = 0.09\ v^{1.95}$
$v = 3.45\ h^{0.513}$
h = head in feet above center line of discharge bell, so includes the velocity head in the discharge cowl.
v = vel. in 3-in. siphon pipe
Q = discharge in sec.-ft.

4-in. Merritt Siphon:

$h = 6.3\ Q^{1.95}$
$h = 0.054\ v^{1.95}$
$v = 4.470\ h^{0.513}$
h = head measured to water level in sump represents total friction head.

Deducting the velocity head at outlet cowl from total head in formula for flow in the Miller siphon, the relation obtained is approximately

$Q = 0.174\ h^{0.5}$
$v = 3.52\ h^{0.5}$
$h = 0.0807\ v^2$

To get an expression for the friction loss in terms of a length of straight pipe to give the same loss, the formula for uncoated cast-iron pipe in Barnes' "Hydraulic Flow Reviewed" was used:

$h = 0.000343\ lv^{1.953} \div d^{1.172}$

for 3-in. pipe

$h = 0.00174\ lv^{1.953}$

The length of straight pipe required to give the same loss of head as the 3-in. Miller siphon

= 0.0807 ÷ 0.00174 = 46.4 ft.

or = 185.6 diameters (neglecting difference in exponent of v)

For 4-in. straight pipe

$h = 0.00124\ lv^{1.952}$

Equivalent length of straight pipe with same friction loss as 4-in. Merritt siphon

= 0.0054 ÷ 0.00124 = 43.6 ft. or 130.8 diameters.

A table in a catalog of a siphon patentee giving the rate of flow for 5 to 30 in. siphons at various heads up to 9 ft. was evidently computed from the formula

$v = 0.45\ \sqrt{2gh}$

This is no doubt satisfactory for approximate results but an exponential formula of the form $v = C\ d^x\ h^y$ should give greater accuracy. The writer knows of no experimental data on large-sized siphons to aid in finding an exponent, x, for the diameter, d, in the formula. The large siphons in service are usually connected with piping systems making tests of the siphon difficult.

Data on friction losses through siphons are of more than theoretical interest. In determining the hydraulics of a sprinkling filter, especially when the head is limited, accurate data are desirable. In such a case it is convenient to express the friction loss in terms of a length of straight pipe having the same loss. A fair guess should be 190 diameters until test data on large sizes give further data.

When a siphon is used in a dosing tank subject to continuous inflow, it is important that the rate of discharge of the siphon at the minimum head be greater than the rate of inflow into the tank. With several types of vents a slight suction of air occurs before complete venting takes place. This results in a considerable reduction of flow. With a vent of this type the minimum flow indicated with no air suction should be divided by two to give a safe value.

Placing Concrete Membrane Lining in Herron Hill Reservoir

Continuous Sheet Two Inches Thick Applied by Cement Gun to Stop Leakage—High Rates of Progress

BECAUSE of costly leakage of water from a high-service water-supply reservoir on Herron Hill, Pittsburgh, Pa., a concrete membrane lining is being placed in the reservoir by cement-gun deposition on a double layer of mesh reinforcement. A lining of the more common type, consisting of two layers of concrete molded in separate slabs, with bituminous waterproofing between the layers, was contemplated at first, but after careful study of the case the decision was reached that a thin reinforced cement-gun lining without waterproofing and without expansion joints would be entirely adequate for the service, and the work is being carried out accordingly.

Definite figures on the leakage from the reservoir were obtained on several occasions in recent years when it was possible to cut off both the pumping and the discharge lines and measure the lowering of water level. The reservoir is of 11.2 million gallons capacity, is about 172 x 305 ft. on the bottom by 24 ft. deep, has side slopes of about 1½ to 1, and carries normally about 22 ft. depth of water. It was built in 1878. The bottom is partly on rock and partly on earth directly overlying rock, all undisturbed soil, while the larger part of the embankment is fill formed from the excavation of the reservoir site. The original

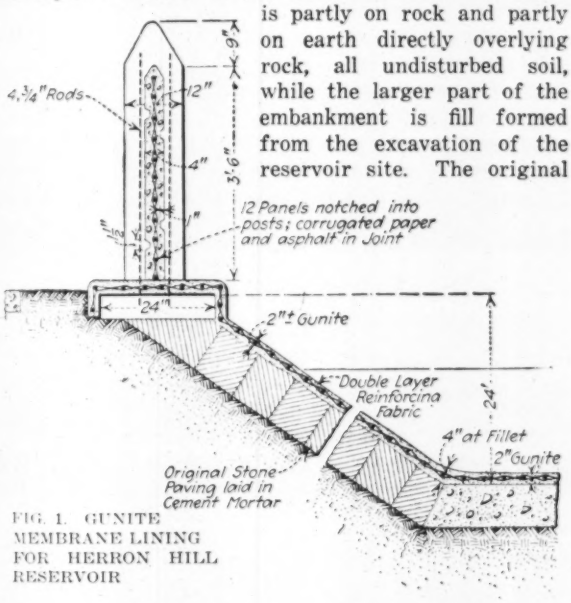


FIG. 1. GUNITE MEMBRANE LINING FOR HERRON HILL RESERVOIR

lining comprised a floor of unreinforced concrete and slope paving of stone blocks laid up in cement mortar. About fourteen years ago a second layer of concrete was placed on the bottom, largely to give the floor a drainage slope to an affluent pipe. Most of this layer has since spalled off.

Old coal-mine workings exist directly under the Herron Hill reservoir, at a depth of about 150 ft. These were worked out at least fifty years ago, and it is not believed that any disturbance of the ground has resulted from them in late years. Nevertheless there has for a long time been a considerable amount of leakage from the reservoir, water appearing both at the mouth of the coal workings and at other points near the base and on the side slopes of the hill. It has been demonstrated that several of these leaks have connection with the reservoir. No tendency of the leakage to decrease could be observed, but at the same time careful analysis of the situation indicated that there was no danger to the structure, and, as the issuing water in all cases was perfectly clear, no soil was being moved by the flow.

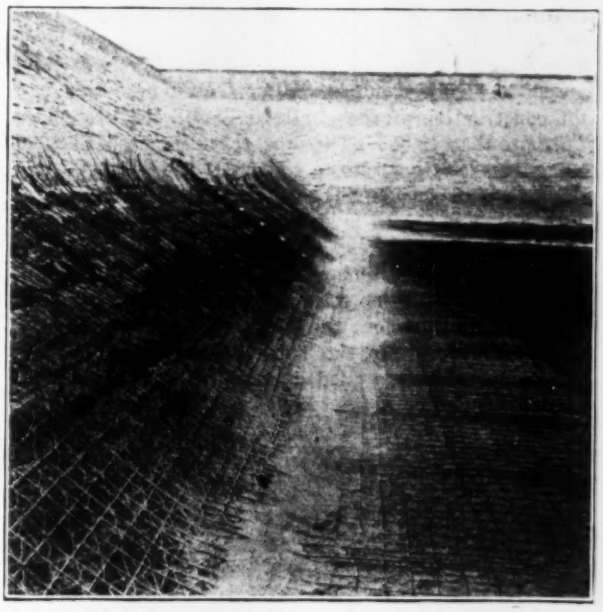


FIG. 2. REINFORCING MESH HELD IN PLACE BY CONCRETE RIDGE AT FOOT OF EMBANKMENT

Calculations of the cost of the water lost by leakage were made several years ago, after it was possible to determine that the amount of the loss was approximately a million gallons per day. As the Herron Hill storage is part of the high-service supply of the city (there are four supply zones, this one having a normal water level 564 ft. above Allegheny River pool level) and is pumped in two stages, the cost of the water is high. Under the conditions, the leakage water was computed as having a value of $7,500 per year, counting only the fluctuating load value to the plant. Therefore an expenditure of $60,000 to stop the leakage would yield a high percentage of return on the investment. The commercial value of the water for selling purposes at city water rates is, of course, many times the load value given above.

Three years ago it was decided that the leakage should be stopped by relining with a waterproofed two-layer concrete pavement. Following standard practice in reservoir lining, the concrete was to be laid in square blocks, breaking joint. But as no settlement was to be apprehended, because of the support furnished by the old lining, consideration was also given to a continuous lining, with either a single contraction joint at mid-length or without any joint. Inspection of a reservoir at Muscatine, Iowa, lined with a thin reinforced cement-gun lining, which after several years' service is free from cracks, finally turned the decision in favor of the continuous type of lining.

Estimates made on both types of lining in spring of this year indicated that the cost would be approximately $125,000 for the two-layer lining with waterproofing, and $55,000 for a continuous cement-gun lining, a difference in favor of the latter of about $70,000. In case the

thin lining should develop objectionable cracks, against all expectation, it would still serve as the lower layer of a waterproofing concrete lining laid in blocks, and proper credit for such use would make the net loss due to the construction of the gunite lining in the first place not more than $8,000. The prospect of a gain of $70,000 as against a rather remote chance of losing $8,000 was an important consideration in the final decision.

In Fig. 1 herewith is shown the design of the lining in its essential features. The old slope paving, of block stone laid in cement mortar, is in such excellent condition as to require no work except the occasional pointing off of a projection; the 2-in. lining of the bottom is therefore carried up the side slopes unchanged, and it is expected that a good bond will be secured by the grip of the gunite on the rough surface of the pavement.

obtained, but it is found that the sand must not carry over 5 per cent moisture to be satisfactory for the purpose. A small bucket car, hauled by cable up an inclined track, takes the cement-sand mixture to a small bin over the gun machines, passing it through a ¼-in. rotary screen before discharging it into the bin, to eliminate oversize particles that might clog the hose. Making a trip in two minutes, this car plant has been able to keep the four machines supplied for full-time operation of the four guns, placing 8,000 sq.ft. of the 2-in. layer in a single day of 8½ hr. A bag of cement lays about 14 to 15 sq.ft. of the 2-in. layer, corresponding to full utilization of the mortar, as none of the material is lost.

With a gage pressure of 80 to 85 lb. of air at the compressors, and about 30 lb. at the gun nozzles, there

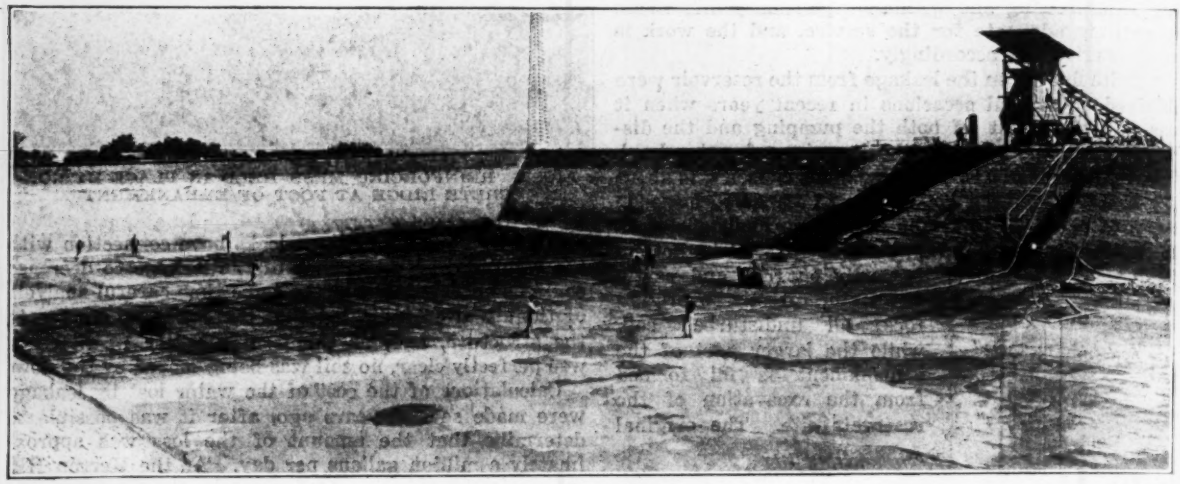


FIG. 2. FOUR GUNS PLACING CONCRETE MEMBRANE, WITH SUPPLY FROM FOUR-MACHINE PLANT ON EMBANKMENT

The lining sheet is continued on up over the old stone coping and down the outside of the coping so as to enclose all the old work. A solid-panel railing and a watchman's house inserted in the railing at one point are also to be built of cement-gun work. The reinforcement throughout consists of two layers of wire mesh in which the sheets run at right angles to each other, and amounts to 0.3 per cent.

In the methods of construction as well as in the design, the work has close similarity to that of relining Lake Elizabeth, a park lake on the North Side, Pittsburgh, described in our issue of Aug. 26, 1920, p. 410. While the two basins are of about equal area, the park lake is only 4½ ft. deep; the 24-ft. depth of the Herron Hill reservoir means a very much greater water load and tendency to crack formation and leakage, for which reason about twice as much reinforcement is used.

Construction is carried out by four cement guns, operated from separate machines set under a charging bin and screening plant on the reservoir embankment, at mid-length of one side. The view Fig. 2 indicates the layout. The dry cement-sand mixture, 1:3 by volume, is made at a mixing plant at the foot of the embankment slope, about 250 ft. from the charging bin. Allegheny River gravelly sand of ¼-in. maximum size is used. The plant consists of a ¾-yd. mixer. With about one minute turning a very intimate mixture is

are only infrequent stoppages through plugging of the hose. In general, with maximum hose length of about 200 ft., the loss of time per gun does not exceed ½ hr. per day. There is no separation of the material and only a minute amount of rebound directly adjacent to the jets. To secure corresponding results in the work on the slopes this part of the placing is to be done from staging laid on the slope, so arranged that the jets can be directed at right angles to the surface.

A total of 105,000 sq.ft. of gunite lining is included in the bottom and slope paving. This was contracted for at 49c. per square foot, to A. V. Purnell, of Pittsburgh. The design and supervision of the work is under the Bureau of Water of the City of Pittsburgh, Charles A. Finley, managing engineer, and E. E. Lanphere, division superintendent of distribution.

Since the preceding was written the new lining has been completed, and on Oct. 26 a test of its tightness was carried out. Inlet and outlet gates were closed, and with water at depth of 21 ft. 8 in. the change in surface elevation was determined by hook-gage readings at the beginning and end of a 24-hour period. The lowering of water level was 0.0208 ft., which for the area of water surface of 86,530 sq.ft., corresponds to 13,500 gals. No allowance was made for evaporation (average temperature 68° F., average humidity 58 per cent, average wind velocity 4 mi. per hr., sky cloudy).

FIG. 4. CLOSE-UP OF GUN OPERATOR

Thus the relining work has reduced the loss of water from nearly a million gallons per day to one-seventieth of that amount, or as much as would flow from a ¾-in. pipe under 5 lb. pressure.

Rails Made from Hot-Top Ingots Show Uniform Structure

To determine the value for rail-making purposes of the Hadfield sink-head ingot process the Pennsylvania R.R. some years ago had comparison rails rolled from a number of imported Hadfield ingots and ordinary ingots made by the Maryland Steel Co. These rails are now in test service, and ultimately should show whether the one kind of rail gives better wear or greater safety against fracture than the other. In the meantime, very thorough studies of the uniformity structure or other quality features of both ingots and rails were made by Dr. George K. Burgess, of the Bureau of Standards. A report of his work as published in *Chemical and Metallurgical Engineering* of Nov. 3 to 17, 1920, shows that the Hadfield ingots were decidedly superior to the others in uniformity and freedom from piping or segregation, that they required only 13 per cent as against 26 per cent top discard to eliminate piping and segregation above 12 per cent, and that the rails compared about the same as the ingots. It is not known whether the service results will similarly favor the Hadfield ingots, but Dr. Burgess concludes concerning the Hadfield type, "it is maintained that its adoption would be a step in the right direction in view of the present heavy casualties and property losses on American railroads."

Self-Cleansing Underground Water Collecting System

THE filter material above and around a wooden gallery under the bed of the North Platte River for 600 ft., to furnish water for a Western city, 100 miles below the Pathfinder dam, becomes clogged periodically with an almost impervious curtain of cementitious material. It is said to be caused by the character of the hard water and the material surrounding the gallery. Temporary relief only has been obtained by excavating since the incrusted material forms again within a few weeks. George T. Prince, consulting engineer, Omaha, Neb., who presented the above data recently before the Iowa section of the American Water Works Association, considered it essential to construct another collecting system with self-cleansing features.

The system proposed by Mr. Prince will consist of 900 ft. of 14-in. cast-iron pipe with tight joints laid 50 ft. from the low water shore line of the river. At intervals of 100 ft. cast-iron special wye castings will be inserted, the branch openings of which will be fitted with a flange to which an 8-in. valve will be bolted. Three 12-ft. lengths of 8-in. flange pipe will be laid from the valves. Perforations in these branch lines will consist of three lines of 1-in. holes, 50 holes in each pipe length, equally spaced and staggered. The outer ends of the pipe will be closed with a blank flange.

Each branch line will be laid for its length of 36 ft. at the same elevation as its connecting wye special in a trench not less than 46 in. in width at the bottom. The trench will be excavated to a depth of at least 12 in. below the pipe and refilled with washed gravel, no particle of which will be less than 2 in. in size, the larger particles being placed next to the pipe. On either side of the flange pipe for a width of 18 in. and on top to a depth of 4 ft., washed gravel of like character to that below the pipe will be placed and above this the trench is to be filled with excavated material.

About once a week it is proposed to close all of the 8-in. valves on the branches of the collecting system and then open each one successively for back-flushing from the reservoir to remove the clogging material.

Mr. Prince makes the following calculation on the hydraulics of the back-flushing procedure:

> Assuming the pipe conditions to be such that 3,000 gal. of reverse flow per minute can be delivered to each branch pipe line under a dynamic head of 70 ft., it is evident that each of the 150 holes in the branch pipe line would have to pass 20 gal. of water per minute, requiring a velocity through the holes of 8.16 ft. per second. If we assume the value of the co-efficient of discharge C to be 0.5 in the formula $V = C\sqrt{2GH}$ and assume H to have a value of 70 ft., the formula would indicate a velocity per second of 32.4 ft. Just how much the velocity would be retarded by the gravel filling around the branch pipe lines is indeterminate, but the above figures would indicate a reduction in pressure of 75 per cent due to the surrounding gravel mass.

Reconstruction of Thirty-third St. Bridge

In the reconstruction of the Allegheny River bridge of the Baltimore & Ohio R. R. Co. at 33rd. St., Pittsburgh, described in *Engineering News-Record*, Nov. 4, p. 904, the company retained J. E. Greiner, of Baltimore, as consulting engineer. Through an oversight Mr. Greiner's connection with the work was not stated in our description.

Enlarging the Facilities of the Harbor of Marseilles

Work Started Before the War Comprises Harbor Breakwater with Large Concrete Blocks, a Huge Tunnel for Ship Canal and Development of Shipping Quays

By Thorndike Saville
Associate Professor of Hydraulic and Sanitary Engineering, University of North Carolina, Chapel Hill, N. C.

SOME of the most important engineering work in France is now being undertaken in the development of the Port of Marseilles and the construction of the Rove Ship Tunnel. Much of this work had been planned shortly before the outbreak of war in 1914, and its accomplishment has been interrupted until the present. The engineering works comprise the following construction.

I. The Grand Jetty. This is a concrete sea wall and dike forming an outer barrier, which runs parellel with the shore and serves to protect the docking basins, of which it forms one side. The sea wall itself acts in part as a dock, and is extended by a dike of masonry blocks to form a fore-port to the basins.

II. The Interior Basins. These are large areas protected by the Grand Jetty, and flanked by quays with freight handling machinery. They are large enough to accommodate and allow to maneuver the largest transatlantic liners entering the Mediterranean.

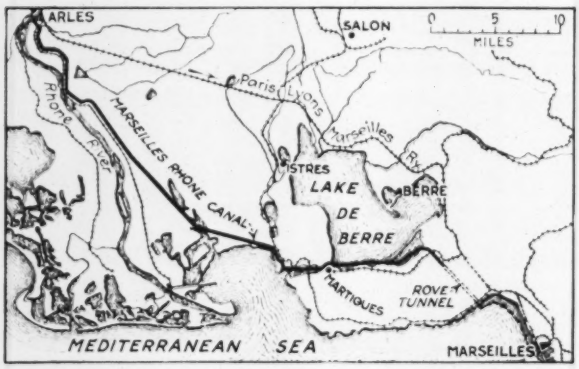


FIG. 1. MAP OF MARSEILLES AND VICINITY, SHOWING CANAL CONNECTION TO THE NORTH

III. A coast-wise canal from the interior basins and port to the Rove Tunnel. This is to allow river barges to come alongside the quays and proceed directly to the Rhone River.

IV. The Rove Tunnel. One of the largest single span tunnels in the world, devised to permit river barges to proceed direct from Marseilles to the Rhone, and thence to the interior of France.

V. The Development of the Etang de Berre. A great inland sea, adjacent to Marseilles, but separated from it by the Rove Hills. It will be connected with Marseilles by the Rove Tunnel, and with the sea by the Straits of Martigues. It is planned to develop here a supplementary port for Marseilles, a barge terminus for river traffic, and a protected naval base.

VI. Canal from Marseilles to the Rhone. This passes along the coast to the Rove Tunnel, through the Etang de Berre and thence to the Rhone at Arles. It forms a direct water highway from Marseilles to Lyons and interior points, and is destined eventually to make possible water communication from Marseilles to Switzerland through Lake Geneva.

Marseilles is the chief port of France, and notwithstanding the severe losses inflicted upon its shipping during the war, its imports in 1916 (the last year for which statistics are available) were 5,704,903 tons and its exports 1,493,535 tons. The chief traffic is naturally import traffic with the Mediterranean ports, comprising 36 per cent of the total, of which 64 per cent is with Africa. Import traffic with the United States, England and India comprised 11, 20 and 11 per cent respectively of the total.

Situated at the head of an excellent harbor near the mouth of the Rhone river, and at the terminus of the great Paris-Lyon-Marseilles Ry. Marseilles is naturally placed to serve all interior France as the principal port for the large Mediterranean trade. Moreover, Marseilles has to a large extent served heretofore as a port for Switzerland also. Within the past decade, however, the equipment of the port has been wholly inadequate to serve the increase of shipping. Thus from 1900 to 1913 the area of the quays and docks was increased some 19 per cent while the total traffic of the port increased 90 per cent. This resulted not only in great congestion of shipping, but in the diversion of a good deal of shipping to other ports. This was notably the case with Genoa, which has greatly improved its port facilities and now handles the greater part of the Swiss trade.

Before the war the Chamber of Commerce of Marseilles had outlined certain comprehensive plans for the enlargement of the port, and itself agreed to bear a large part of the expense. The first and most pressing need was for additional docking space. This was greatly accentuated after the outbreak of war by the allocation of certain docking space to the French and British army bases, and in consequence those parts of the plan of port development most susceptible of rapid accomplishment were pushed energetically.

The Great Jetty

All of the newer basins of the Port of Marseilles are formed behind a great sea wall running parallel with the shore. This arrangement of sea wall and basins is shown in Fig. 2. This is to be continued toward the north as new basins are constructed. The wall is kept always a little in advance of the northernmost basins to form a protection for the entrance. As the basins are added, the wall is widened on the basin side to form a quay. The method of construction is shown in Fig. 3, and the additions necessary to form the Terminal Quay are noted.

The masonry blocks indicated in Fig. 3, and shown in the photographs, form a novel feature of construction in the port. They not only serve for protection to the Grand Jetty, but are used to form the quay walls and to protect the dikes forming the canal to the Rhone described hereafter. They are of masonry construction measuring 4 x 2 x 1.75 meters (13 ft. 2 in. x 6 ft. 7 in. x 5 ft. 9 in.) and weigh about 30 tons. They are manufactured in a construction yard near the entrance to the Rove tunnel, and the limestone rocks excavated from the tunnel are embodied in them. The

cement is of lime, and a very coarse limestone sand is used. As shown in the views mechanical handling is extensively used in the yard and in getting the blocks to the wall.

Work on the quays forming the Madrague (now renamed the President Wilson) Basin was pushed during the war, and at the end of hostilities some 2,500 lin. ft. of quays were available for shipping. This comprised space along Mole G and the Terminal Quay. The basin is now being completed by finishing the Terminal Quay immediately behind the Grand Jetty and by the construction of the "Traverse du Cap Janet" forming the north end of the basin. A depth of water of 39.5 ft. is provided.

The quays are formed by sinking concrete caissons onto prepared foundations and building up the quay on the caissons. The caissons are built in a construction yard and consist of a reinforced-concrete shell containing multiple hollow sections. Steel forms are used and the caissons are made of sufficient sections to form the desired length. The caissons are floated to their desired position, sunk, and the sections filled with concrete. Fig. 8 shows a caisson sunk in place at the end of the west side of the "Traverse du Cap Janet."

The President Wilson Basin, with its approaches and foreport will probably be entirely completed early in 1920. This will increase the water area of the port by some 100 acres and the length of quays by about 3,600 lin. ft. which will augment the total capacity of the port by about 15 per cent. The development project then calls for the construction of the Mirabeau basin to the north of and adjoining the President Wilson basin. This is shown by dotted lines in Fig. 2 and will add some 20,000 lin. ft. of quays. The cost is estimated (1918) at about $22,500,000 and will be borne by the Chamber of Commerce of Marseilles. It will not be completed before 1924 or 1925.

There is also, in the general project of enlargement, a plan for a great new basin extending south of the National Basin to the present Joliette basin and called Jolliette basin No. 2. This would add 63 hectares (156 acres) of water to the port and 12,210 lin. ft. of quays with a minimum depth of 43 ft. It would serve particularly the passenger and mail traffic of the great transatlantic and Mediterranean steamship lines. It will be, however, some years before this work is started.

To connect the docking basins of Marseilles with the Rove Tunnel, a protected waterway has been built following in general the outline of the shore. This is constructed by means of a dike, built at 300 to 350 ft. from shore. The minimum depth will be 3 m. (9 ft. 10 in.) to accommodate the standard 600 ton barges, consisting simply of standard masonry blocks.

With the completion of the President Wilson basin the greatest need for the immediate future will be for adequate storage space for merchandise. Indeed, this is a pressing necessity which is constantly becoming more acute. Marseilles is very densely built over the seaward slopes of hills bordering the sea. The railways enter through tunnels in the hills, and there is available very little flat ground for the storage of freight pending its interchange between railroad, canal barge, or ship. In consequence there is ever-increasing congestion at the docks and often loss of time and efficiency through inability of small boats to discharge their cargoes quickly.

In Fig. 2 there is shown in dotted lines the proposed location of certain "Terre Pleins" or filled land where storage depots will be created. In connection with these there will be certain small basins created in the existing bays as termini for the canal boats. This development, however, carried to its fullest extent, will not be sufficient to serve the needs of the increasing traffic of the port and additional space will have to be found on the lands adjoining the Etang du Berre.

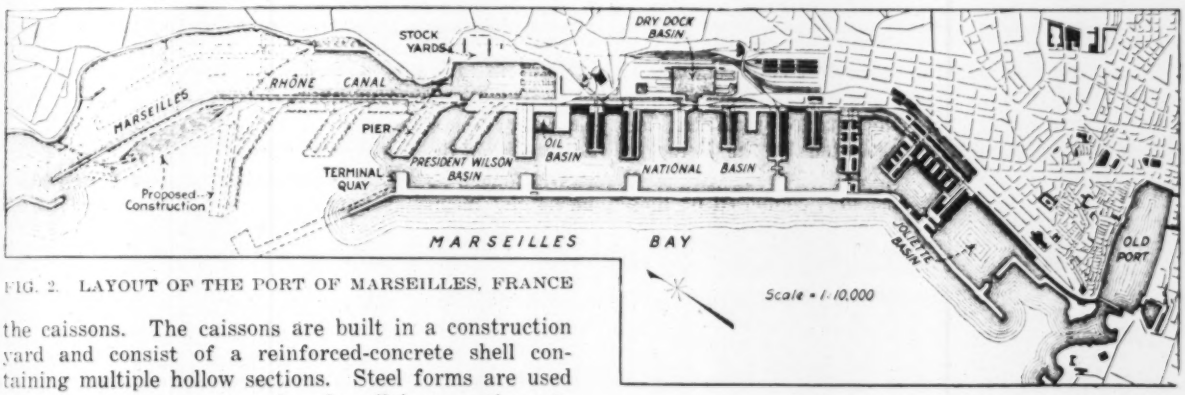


FIG. 2. LAYOUT OF THE PORT OF MARSEILLES, FRANCE

Probably the most gigantic and spectacular engineering construction now being prosecuted in France is the Rove Ship Tunnel. It is of particular interest not only because it is the largest tunnel in the world, but also because of the very carefully considered methods devised for its construction, all of which have thus far proved eminently successful. The tunnel will connect the coastal canal and port of Marseilles with the Etang du Berre on the northern side of the hills which border the coast from Marseilles to the mouth of the Rhone. From the northern end of the tunnel there will be direct communication by canal with the Rhone at Arles. Earlier progress on this tunnel was described in *Engineering News*, Aug. 26, 1915, p. 386, Oct. 21, 1915, p. 803 and Nov. 30, 1916, p. 1013.

The general dimensions of the tunnel are shown in Fig. 9. The dimensions were decided upon only after much discussion in which it was finally decided that a width was desirable sufficient for boats to pass going in each direction. Before the tunnel was commenced, two shafts were sunk, one in the middle of the Rove Hills, 2,500 meters (8,250 ft.) from the south end, the other near the Etang de terre. The first had a depth of about 460 ft., the second about 230 ft. Both shafts were 11.5 ft. in diameter and were located 39 ft. off the centre line of the tunnel. They both penetrated a marly limestone of which the hills are composed. Indeed the geological characteristics of these hills along the line of the tunnel are singularly simple. There

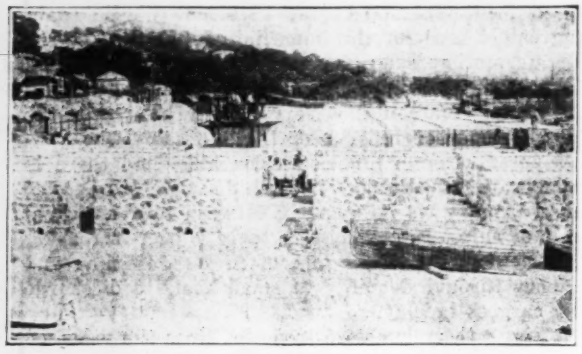


FIG. 4. CONSTRUCTION YARD FOR MASONRY BLOCKS USED IN GRAND JETTY

FIG. 5. MASONS MAKING BLOCKS FOR CONSTRUCTION OF GRAND JETTY

are no faults, nor subterranean streams of any magnitude. The drainage from the entire tunnel is carried by a 12 in. pipe serving several small centrifugal pumps. The rock is a fine grained limestone which decomposes on exposure to the air and moisture, but remains firm enough when protected by the lining of the tunnel.

The tunnel is lined with masonry, composed of lime-

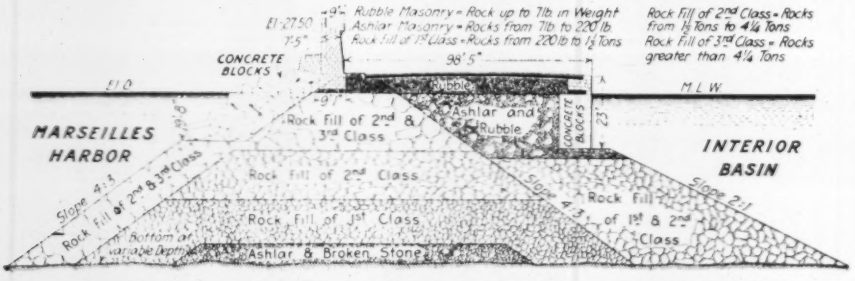

Rubble Masonry = Rock up to 7lb in Weight
Ashlar Masonry = Rocks from 7lb to 220 lb
Rock Fill of 1st Class = Rocks from 220 lb to ½ Tons
Rock Fill of 2nd Class = Rocks from ½ Tons to 4¼ Tons
Rock Fill of 3rd Class = Rocks greater than 4¼ Tons
El 27.50
7.5"
CONCRETE BLOCKS
98'5"
El 0
M L W
Rubble
Ashlar and Rubble
Rock Fill of 2nd & 3rd Class
MARSEILLES HARBOR
INTERIOR BASIN
Rock Fill of 2nd Class
Rock Fill of 1st Class
Rock Fill of 1st & 2nd Class
Slope 4:3
Slope 2:1
Bottom at variable Depth
Ashlar & Broken Stone

FIG. 3. CROSS-SECTION OF THE EXTERIOR JETTY AT MARSEILLES

stone blocks set in lime cement. The blocks are taken partly from the rock excavated from the tunnel after being shaped up, and partly from near-by quarries. The mortar is formed of equal parts of coarse limestone sand and "maritime chalk." The latter is in the nature of a very calcareous natural cement manufactured at Teil. The resulting mortar is coarse, and it is not believed that the bonding strength is very great. The finished lining is not smooth or workmanlike in appearance. The thickness of the lining depends upon the nature of the ground traversed. The strongest was designed to withstand a pressure of 31 kgm. per sq.cm. (44 lb. per square inch).

The method of penetration of the tunnel is of interest, and is shown graphically in Fig. 9. The right hand pilot cutting is kept slightly in advance of that on the left. Each is between 75 and 100 sq.ft. in area of cross-section. Between the two there are established galleries at intervals of 330 ft. which serve for ventilation, location of machinery, storage of equipment, explosives, etc. When the two lateral galleries have been driven some distance, a third cutting is started in the middle, near the top. This cutting is connected by chutes to the lateral galleries on either side, and the material excavated is dumped through them into cars in the lateral galleries. The excavation then continues in all three galleries until the arch is completed. The lining is then placed, being built from each springing line and carried by wooden forms held by metal frames of H-section. The frames are supported on wooden struts and are spaced about 5 ft. apart. The arch is built in alternate sections of about 20 ft. in length as a precaution against accidents. Excavation is carried to the springing line at El-1.50 m. throughout, after which the bottom is carried to El-3.00 m.

The materials are brought in and the excavation removed by means of narrow-gage railways in each of the lateral galleries. In the larger parts of the tunnel small train locomotives are used and in the galleries the locomotives are driven by compressed air. The material excavated is used partly in making the masonry blocks for the jetties and partly for the blocks used in lining the tunnel. Excavation is accomplished by drilling with Ingersoll-Rand compressed air drills, blasting, and removal of the excavated material by hand to the dump cars. Progress is necessarily very slow, the maximum rate of excavation being about 450 cu.yd. per day with a total in the tunnel of some 450 men. Progress would be greatly expedited by steam shovels, which could readily be used under the prevailing conditions. At the present rate of progress the tunnel will not be completed before 1924. Work is carried on by 3 shifts of 8 hours each. Laborers are paid (1919) 24c. per hour. The 4½ miles of tunnel was contracted for at 47,949,520 francs ($9,250,000) before the war. The ultimate cost will doubtless be 75 per cent in excess of this sum.

The Etang de Berre is a large inland body of water connected with the ocean by a narrow strait between Port de Bouc and Martigues. On the southern border of this the Rove Tunnel has its northern end, some 5½ miles from the Port of Marseilles. The Etang de Berre furnishes a great natural interior harbor capable of serving equally as a terminus for the barge traffic from Marseilles and the Rhone, and as a supplementary Marseilles port for shipping which will enter through the straits at Martigues. For this purpose it is planned eventually to dredge a passage from the sea to Martigues 270 ft. wide and 46 ft. deep. At present there is entrance only by canal, the depth of which is 20 ft.

The lack of storage space in the vicinity of Marseilles has been noted above. The borders of the Etang de Berre present an area singularly well situated for

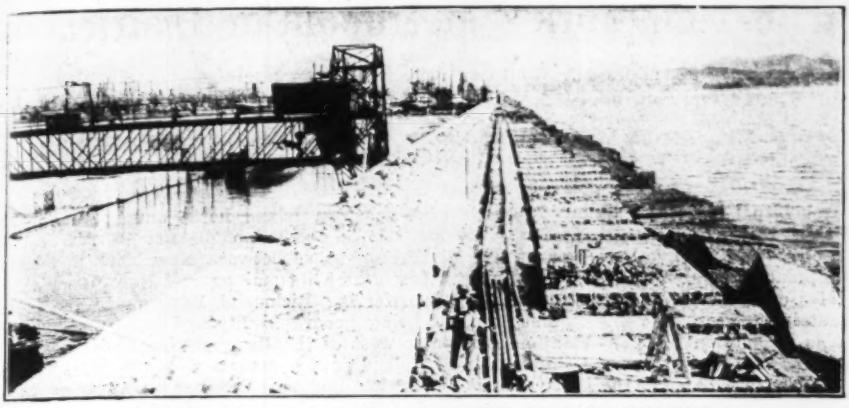


FIG. 6. TERMINAL QUAY. CONCRETE DISTRIBUTOR FOR FILLING SUNKEN CAISSONS

FIG. 7. CRANE TO HANDLE 30-TON BLOCKS

handling the great interior traffic of Marseilles—especially the enormous increase which will come with the canalization of the Rhone between Marseilles and Lyon. Already enterprising organizations are buying up ground on the shores of the Etang and constructing wharves there. The Etang de Berre is destined without doubt to become a great interior port and harbor of refuge as well as serving as a protected naval base.

There exists already a canal from Arles on the Rhone to the Etang de Berre, which was begun by the first Napoleon. This is being deepened and the locks at Arles increased in size. Eventually the canal will be 82 ft. wide, and will have a minimum depth of 8 ft. except between Marseilles and the Etang de Berre where it will be 10 ft. The dimensions of the canal are chosen to accommodate the standard canal boat of 600 tons. These boats are 60 m. (197 ft.) long by 8 m. (26 ft. 3 in.) wide and draw 1.75 m. (5 ft. 9 in.) of water. The steam tugs which will go from Marseilles to the Etang de Berre draw 8 ft. 3 in. and consequently that portion of the canal has a depth of 10 ft. The canal between Martigues and the entrance to the Rove Tunnel is formed merely by constructing a breakwater off shore along the Etang de Berre similar to that described above for the canal between Marseilles and the Rove Tunnel.

There will be only one set of locks at Arles, which will have a width of 52.5 ft. and a length of 525 ft. This will equalize the difference in level between the Rhone at Arles and the Etang de Berre, a difference varying from 23.6 ft. (highwater) to 0.5 ft. (low water). The present lock at Port de Bouc will be eliminated.

The writer desires to acknowledge the courtesy of Monsieur M. Bezault, ingenieur en chef des Ponts et Chaussees at Marseilles who arranged for a visit to the works at the Rove tunnel and provided several maps and much information descriptive of this work.

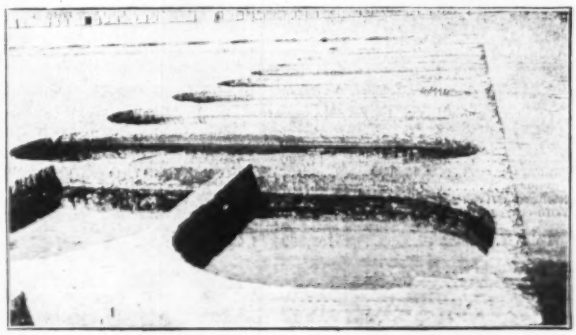


FIG. 8. CAISSONS SUNK BUT NOT FILLED FOR PRESIDENT WILSON BASIN

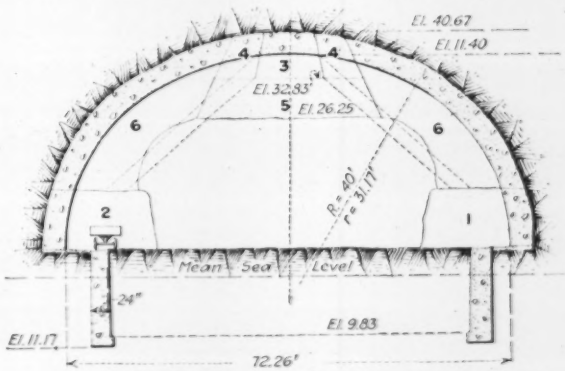


FIG. 9. SECTION OF THE ROVE SHIP TUNNEL

M. Fabre, ingenieur ordinaire des Ports et Chaussees at Marseilles arranged for the writer to visit the port works and provided maps and diagrams illustrative of construction now under way.

Traffic on New York-New Haven Highway

As an indication of the extent to which traffic passes over improved highways at night the following traffic figures, taken by the Connecticut Highway Department, are cited. This count was made at the Washington Bridge, Stratford, Conn., on the main New York-New Haven highway.

	Passenger Traffic			Trucks	
Oct. 27	Midnight, 8 a.m.	338		Midnight 8, a.m.	103
	8 a.m.—4 p.m.	1,168		8 a.m.—4 p.m.	358
	4 p.m.—12 m.	910		4 p.m.—12 m.	192
	Total		2,416	Total	653
Oct. 30	Midnight, 8 a.m.	363		Midnight, 8 a.m.	112
	8 a.m.—4 p.m.	1,779		8 a.m.—4 p.m.	352
	4 p.m.—12 m.	842		4 p.m.—12 m.	192
	Total		2,984	Total	656
Oct. 31	Midnight, 8 a.m.	169		Midnight, 8 a.m.	80
	8 a.m.—4 p.m.	1,770		8 a.m.—4 p.m.	73
	4 p.m.—12 m.	2,515		4 p.m.—12 m.	90
	Total		4,454	Total	243

Transportation in New York's Metropolitan District

Extracts from Address Before New York Section, American Society of Civil Engineers, Nov. 17, 1920

By HENRY M. BRINCKERHOFF
of Parsons, Klapp, Brinckerhoff & Douglas, Consulting Engineers, New York City

LET us first free our minds of our habitual ideas of New York as Manhattan Island and think rather of the great surrounding district extending even outside of the five boroughs of Greater New York. The population of Manhattan New York by the 1920 United States census is 2,784,103. Close scrutiny discloses the fact that in 50 years two important changes have occurred: The population of Manhattan Island has reached its maximum and started to recede, having lost nearly 50,000 in the past decade; and the

FIG. 1. A CIRCLE OF 15-MILE RADIUS INCLUDES MOST OF NEW YORK'S METROPOLITAN DISTRICT

old Manhattan New York as an independent, self-contained city no longer exists. The New York of our fathers has overflowed into or been merged with the life of its surrounding neighbor communities.

For our purpose we may take the New York Metropolitan District substantially as defined by the United States Census Department and as shown in Fig. 1. Taking the intersection of Thirty-fourth St. and Fifth Ave. of Manhattan as the urban center of activity and describing circles with 5-, 10-, 15- and 20-mile radii we find that this Metropolitan District lies mostly within the 15-mile circle and all within 20 miles of the center. The cities grouped around Manhattan New York and included in our metropolitan area lie as far east as Flushing and Far Rockaway, Yonkers on the north and Paterson, Newark and Elizabeth to the west. Fifty years ago these latter were remote and totally unrelated communities but today the whole group, with New York as a center, has by a process of growth and development merged into a single metropolitan community in spite of geographical obstacles and political boundaries.

The conception of this whole district as a metropolitan unit, a single city, involves an urban and suburban traffic view in which Manhattan Island figures as the central delivery district for this larger area, with subcenters of activity in Brooklyn, Newark, Yonkers, etc., but all related to one another by the common necessity of easy, frequent passenger intercommunication.

The axis of Manhattan Island north and south almost exactly divides this metropolitan district in two equal parts. The division of areas between New York and New Jersey shows New York 333 sq.mi. against New Jersey with 239 sq.mi. Transferring Richmond Borough to the New Jersey side as being geographically and from a transportation standpoint west of the Hudson River, and considering Manhattan Island as a passenger delivery district with the remaining territory of the metropolitan areas as tributary, we find 263 sq.mi. east and 261 sq.mi. west of this central district.

Distribution and Growth of Population.—Transportation requirements have a direct relation to the number of people in the area to be served and also to their distribution residentially as well as the location of their places of occupation. At least 50 per cent of the passenger traffic handled by city transportation lines consists of workers going daily from homes to places of employment and return. The tendency of population growth is important, then, in an analysis of the transportation needs we are considering.

Table I shows the population for 100 years by 50-year periods of this metropolitan district, and the densities per acre at present.

TABLE I. POPULATION DISTRIBUTION IN METROPOLITAN DISTRICT

	1820	1870	1920	Per Acre 1920
Manhattan	123,000	942,000	2,284,000	163
Brooklyn	11,000	420,000	2,018,000	46
Bronx	.....	.....	732,000	27
Queens	22,000	74,000	469,000	7
Richmond	6,000	33,000	117,000	4
Yonkers	1,600	18,000	210,000	7
Total N. Y. State	163,000	1,487,000	5,830,000	Ave. 27
Bergen County	9,000	30,000	120,000	3
Hudson County	9,000	129,000	630,000	34
Passaic County	.....	39,000	220,000	12
Essex County	12,000	133,000	620,000	18
Union County	.....	31,000	130,000	4
Total in N. J.	30,000	362,000	1,720,000	Ave. 11
Total, for Metopolitan Area	193,600	1,849,000	7,550,000	Ave. 21

Two important points are to be noted from Table I: The ratio between the population east and west of the river has remained pretty constant for the past 100 years and the denser and larger population groups were located close to the harbor shipping development. This ratio of about 5 to 1 was true up to about 1900, but then the rapid transit lines began to stimulate the eastern or New York territory into a growth producing a ratio of 6 in New York to 1 in New Jersey in 1920.

We have now come to a point when further rapid transit plans are placed before us by our Public Service Commissioner, which are the result of a long period of study of the subject by the chief engineer, Mr. Turner. (See *Engineering News-Record*, Oct. 14.) Hampered by the limitations of state boundaries he has followed to a logical conclusion, Fig. 2, the result of distributing further large population increases by lines built exclusively in New York State and leaving the New Jersey side to take care of its own problem. We have been asked to disregard such limitations and to consider this subject from the broad metropolitan standpoint.

Mr. Turner predicts that corporate New York (the five boroughs) will grow to 9,000,000 population by 1945. He finds by a further development of the idea of north and south rapid transit lines on Manhattan Island that at least two eight-track subway lines will be required.

From a general economic standpoint the fact is apparent that the vital necessities for the maintenance of a great city

FIG. 2. TRANSIT CONSTRUCTION COMMISSION'S PLAN

population—food, fuel and water—come to this metropolitan district from the west and that the cost of transporting the two former from the west side of the district to Brooklyn and Queens is almost as great as the cost of hauling from Pittsburgh to Newark. This line of thought naturally leads to a suggestion that from the metropolitan standpoint at least a portion of the new population should be located west of the Hudson and that east and west rapid transit lines crossing Manhattan Island from Queens and Brooklyn to Bergen and Hudson Counties in Jersey are warranted and would bring about a better distribution of population relatively to Manhattan.

A rectangular system with transfers at the intersections would tend to distribute the development more evenly across Manhattan Island instead of the great congestion from four- and eight-track subways on north and south avenues (proposed in the Turner report). A shorter average haul would also be obtained and more balanced two-way traffic developed than by forcing the population growth entirely to the east. In Fig. 3 a general suggestion for such lines is shown to convey the idea of a gridiron system in relation to the whole metropolitan area. These east and west rapid transit tracks could be fed by the transfer from the present or new surface lines.

Present Transportation Needs.—More interesting to the average man than the future is the question of how he is to get to and from his work now. Having analyzed the general conditions and pointed out broad lines for thought upon the general scheme we can turn to our own troubles of today. Upon what transit facilities are we now dependent in metropolitan New York? In the reverse order of their importance by volume of passengers handled daily, they are as follows:

TABLE II. CLASSES OF TRANSPORTATION AND DAILY TRAFFIC, NEW YORK METROPOLITAN DISTRICT

	Per Cent of Total
Buses:	
Fifth Avenue Company and city buses	2
Ferries	5
Steam railways entering New York	4
Surface lines	35
Rapid Transit:	
Elevated and subways	54

This subdivision of traffic is peculiar to New York. In London the ratios are as follows: Bus, 33 per cent of total; surface cars, 27 per cent; rapid transit, 40 per cent.

In Chicago the situation is again different, the rapid transit lines being less developed: Surface cars, 75 per cent of total; rapid transit, 21 per cent; steam suburban, 6 per cent.

The passengers delivered to Manhattan by steam railway lines on an average weekday are: From the west, 167,000; from the north, 57,000; from the east (including those delivered by the Long Island Railroad to Brooklyn and Queens), 74,000; total, 288,000.

Similarly the traffic carried to Manhattan by ferries, excluding that of steam railway origin, is: From the west, 142,000; from the east, 92,000; from the south, 30,000; total, 264,000.

Into lower Manhattan, i.e., below Fifty-ninth St., or an area of 10 sq.mi., there is daily poured over 2,000,000 people.

This daily inflow to lower Manhattan is equal to one-fourth of the population of the metropolitan district, but of course a portion come from upper Manhattan and a small number from suburban territory beyond the limits selected. With double or certainly with triple the present population this concentrated central traffic movement would mean the displacing of a large part, if not all, of the resident population of Manhattan.

A study of the rate at which this centralized traffic has increased and the fact that it has developed largely coincident with the great rapid transit development of the past twenty years is cause for careful consideration before we adopt either the rate of increase shown or the growth of the traffic itself. Like the tendency indicated all over the United States by the 1920 census of a concentration of population in cities the thought occurs at once that this character of central travel must have some limit. If you bring all the people of the country into cities they will starve, and if you move more than a certain number into Manhattan daily they cannot walk about on the sidewalks.

We know that the old law, thought to be fundamental during the period of development of electric traction, that the riding per annum per capita of population increased as

FIG. 3. PLAN SUGGESTED FOR METROPOLITAN DISTRICT RAPID TRANSIT

the square of the population, cannot be applied to an increase from 1,000,000 to 5,000,000, for instance. In dealing with this matter quantitatively we must, therefore, be on our guard. Subcenters, as the retail districts of Brooklyn and Newark, will grow in importance and a reaction must set in against such continued increased concentrations.

Such a subcenter development will mean more local traffic of a type quite different from that carried by our long rapid transit lines.

Comparative Costs.—The most expensive type of transportation used by urban and suburban travelers in the New York metropolitan district is the steam railway penetrating to the heart of Manhattan and using a large terminal

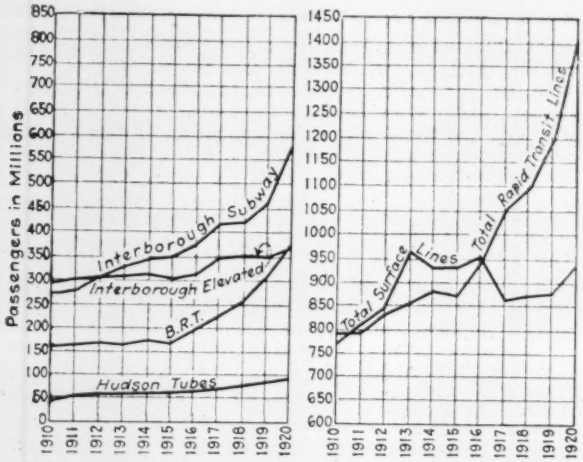


FIG. 6. PASSENGER TRAFFIC IN GREATER NEW YORK

track have doubled on the rapid transit system of Greater New York. The surface lines have increased their tracka only 5 per cent. This is explained by the great rapid tran program which has been put through in this time.

The fact is that the best service to the public can be obtained by a unified co-ordinated system in which each ty will function to the best advantage and as part of a unified whole. This is a pretty big order, but as compared to the process of disintegration and dismemberment which is now taking place it is plainly the right direction in which to work. The nearer we can approach to a single system distributing its load among its constitutent parts in the most effective way for both service and economy the nearer we will attain to 100 per cent economy and 100 per cent service.

More subways are of course inevitable but let us build them as long haul trunks and feed them with surface lines and buses. Thirty-five per cent of the passengers in the metropolitan district use surface electric cars today because they are the most convenient. A study of the needs of the metropolitan district as a whole suggests a necessity for a combined system cheap enough in its outlying sections to permit of wide distribution of travel. If the

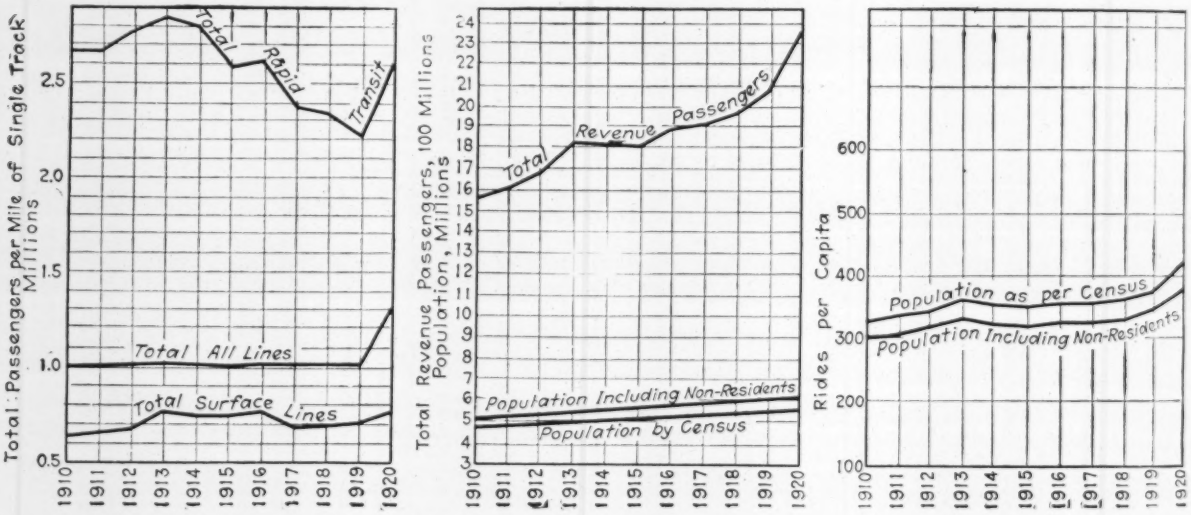


FIG. 4. PASSENGER TRAFFIC IN GREATER NEW YORK FOR PAST ELEVEN YEARS

Left-hand chart shows total passengers per mile of single track. Middle chart shows total revenue passengers and population of New York City. Chart at right shows revenue rides per capita in New York City.

station. Fortunately for the later solution of the problem the volume of this travel is relatively small compared to the rapid transit and surface lines.

It is a fact which is not generally realized, however, that as a city grows not only does its own local and suburban traffic into these great "steam" railway terminals increase but the long distance travelers grow in number also at an equal or even greater rate. With limited track capacity for carrying these two classes of traffic both cannot increase indefinitely. One or the other must ultimately give way. From this type of transportation we cannot hope for present relief, and, on the contrary, part of their load may soon have to be taken over by city rapid transit lines.

Subways cost per mile of single track thirty-five times as much as a bus line and can haul only seven times as many passengers per hour. This would seem a strong argument for buses. To try to haul a full subway load, however, on a bus system requires seven lines of buses in each direction, or a street twice as wide as Fifth Avenue at Forty-second Street. The cost of widening such a street would be fabulous and far more than the subway. This simply illustrates by a comparison of extremes that each type of transit has a peculiar field of its own and if we attempt to handle bus travel on a subway we will be just as wrong as to attempt to carry subway crowds on buses.

Growth.—During the past ten years the miles of single

engineers can put out such a plan then it will be up to the lawyers, city officials and bankers to solve their part of the metropolitan transportation problem.

The Political Question.—I have purposely omitted mentioning the one great stumbling block in the way of a logical, sane solution of this metropolitan problem — *the political question.* Right down the center of the Hudson River we have an artificial political Chinese wall, the boundary between the State of New York and the State of New Jersey. Almost one hundred years ago an engineer designed a steamboat that could plow right across this Chinese wall on the surface of the Hudson; more recently engineers have built railway tunnels under this wall and river; today engineers stand ready to build bridges over this wall and across the Hudson River. As an engineer, let me point out to our political friends how this Chinese wall can be finally and forever removed:

Let us add a forty-ninth state to the Union and name it the State of Manhattan. Let is include the New York metropolitan district as a single self-governing state. Let us leave New York City, Jersey City, Newark, each with its own mayor, its own local government, but let us place matters of common interest to the whole metropolitan area, such as transportation, water, sewerage and port development, in the hands of a governmental body representing the people of all metropolitan New York.

The Engineer's Relation to Our Industrial Problems

By Herbert C. Hoover
President, American Engineering Council

(Address Delivered at First Meeting of Governing Body of the Federated American Engineering Societies, Washington, D. C., Nov. 19.)

THE federation of engineering societies, embracing the membership of between 100,000 and 200,000 professional engineers, has been created for the sole purpose of public service. This initial meeting surely warrants some discussion of a few of the problems to which this organization, for expression of the engineering mind, can quite well give consideration.

Some of the greatest of the problems before the country and, in fact, before the world are those growing out of our industrial development. The enormous industrial expansion of the last fifty years has lifted the standard of living and comfort beyond any dream of our forefathers. Our economic system under which it has been accomplished has given stimulation to invention, to enterprise, to individual improvement of the highest order, yet it presents a series of human and social difficulties to the solution of which we are groping. The congestion of population is producing subnormal conditions of life. The vast repetitive operations are dulling the human mind. The intermittency of employment due to the bad co-ordination of industry, the great waves of unemployment in the ebb and flow of economic tides, produce infinite wastes and great suffering. Our business enterprises have become so large and complex that the old personal relationship between employer and worker has to a great extent disappeared. The aggregation of great wealth, with its power of economic domination, presents social economic ills which we are constantly struggling to remedy.

I propose to traverse only a small fraction of these matters. I do not conceive that any man or body of men is capable of drafting in advance a plan that will solve these multiple difficulties and preserve the system which makes individual initiative possible. We have presented to us economic social patent medicines of one kind or another and, in fact, the great panacea of socialism is today in actual trial in its various forms. In Russia the attempt has been made to apply the most extreme form of complete communism. The Russian experiment is bankrupt in production. The populations of our modern states have been built up to numbers dependent upon an intensity of production that can only be maintained by stimulation of individual effort through the impulse of self-interest, and a departure from this primary incentive to production has now been demonstrated to lead only to famine and flame and anarchy. We have even had a gigantic experiment imposed upon the United States by the war in the necessity to operate a vast merchant marine at the hands of the government, with a result that should offer little consolation to those who advocate even the mildest application of socialism.

Problems of Regulation

We have built up our present civilization, polictical, social and economic, on the foundation of individualism. We have found in the course of development of large industry upon this system that individual initiative can be destroyed by allowing the concentration of industry and service, and thus an economic domination of groups over the whole. We have therefore built up public agencies intended to preserve an equality of opportunity through control of possible economic domination. Our mass of regulation of public utilities and of many other types of industry, aiming chiefly to prevent combinations in restraint of free enterprise, is a monument to our attempts to limit this economic domination—to give a square deal. This regulation is itself also proof of the abandonment of the unrestricted capitalism of Adam Smith. While our present system of individualism under controlled capitalism may not be perfect the alternative offers nothing that warrants its abandonment. Our thought, therefore, needs to be directed to the improvement of this structure and not to its destruction.

A profound development of our economic system apart from control of capital and service during the last score of years has been the great growth and consolidation of voluntary local and national associations. These associations represent great economic groups of common purpose, and are quite apart from the great voluntary groups created solely for public service. We have the growth of great employers' associations, great farmers' associations, great merchants' associations, great bankers' associations, great labor associations—all economic groups striving by political agitation, propaganda and other measures to advance group interest. At times they come in sharp conflict with each other and often enough charge each other with crimes against public interest. And to me one question of the successful development of our economic system rests upon whether we can turn the aspects of these great national associations toward co-ordination with each other in the solution of national economic problems, or whether they grow into groups for more violent conflict. The latter can spell breakdown to our entire national life.

The Engineer's Position

This engineers' association stands somewhat apart among these economic groups in that it has no special economic interest for its members. Its only interest in the creation of a great national association is public service, to give voice to the thought of the engineers in these questions. And if the engineers, with their training in quantitative thought, with their intimate experience in industral life, can be of service in bringing about co-operation between these great economic groups of special interests, they will have performed an extraordinary service. The engineers should be able to take an objective and detached point of view. They do not belong to the associations of either employers or labor, of farmers, or merchants or bankers. Their calling in life is to offer expert service in constructive solution of problems, to the individuals in any of these groups. There is a wider vision of this expert service in giving the group service of engineers to group problems.

We have just passed through a period of unparalled speculation, extravagance and waste. We shall now not only reap its inevitable harvest of unemployment and readjustment but we shall feel the real effect of four years of world destruction, and from it economic and social problems will stand out in vivid disputation. One of the greatest conflicts rumbling up in the distance is that between the employer on one side and organized labor on the other. We hear a great deal from extremists on one side about the domination of the employer and on the other about the domination of organized labor. Probably the tendency to domination exists among the extremists on both sides. One of the most perplexing difficulties in all discussion and action in these problems is to eliminate this same extremist. There are certain areas of conflict of interest, but there is between these groups a far greater area of common interest, and if we can find measures by which, through cooperation, the field of common interest could be organized then the area of conflict could be in the largest degree eliminated.

In this connection the employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers and yet the labor organizations as they stand today are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possible initiative on the part of the employer; and further, that in the long run we can only expand the standard of living by the steady increase of production and the creation of more goods for division over the same numbers.

The American Federation of Labor has publicly stated

that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance not only to the Federation of Labor but also to the other great economic organizations interested in this problem, such as the Employers' Association and the Chambers of Commerce.

Three Causes of Industrial Waste

It is primary to mention the three-phase waste in production: First, from intermittent employment; second, from unemployment that arises in shifting of industrial currents, and third from strikes and lockouts. Beyond this elimination of waste there is another field of progress in the adoption of measures for positive increase in production.

In the elimination of the great waste and misery of intermittent employment and unemployment we need at once coordination in economic groups. For example, our engineers have pointed out time and again to the bituminous coal industry where the bad economic functioning of that industry results in an average of but 180 days' employment per annum, where a great measure of solution could be had if a basis of co-operation could be found between the coal operators, the coal miners, the railways and the great consumers. The combined result would be a higher standard of living to the employees, a reduced risk to the operator, a fundamental expansion of economic life by cheaper fuel. With our necessary legislation against combination and the lack of any organizing force to bring about this co-operation the industry is helpless unless we can develop some method of governmental interest, not in governmental ownership, but in stimulation of co-operation in better organization.

In help against the misery in the great field of seasonal and other unemployment we indeed need an expansion and better organization of our local and federal labor exchanges. We have a vast amount of industry, seasonal in character, which must shift its labor complement to other industries. The individual worker is helpless to find the contacts necessary to make this shift unless the machinery for this purpose is provided for him.

In the questions of industrial conflict resulting in lockouts and strikes one mitigating measure has been agreed upon in principle by all sections of the community. This is collective bargaining, by which, whenever possible, the parties should settle their difficulties before they start a fight.

It is founded not only on the sense of prevention but on the human right to consolidate the worker in a proper balanced position to uphold his rights against the consolidation of capital. This measure, advocated for years by organized labor, was agreed to by the employers' group of the First Industrial Conference. It has been supported in the platform of both political parties. The point where the universal application of collective bargaining has broken down is in the method of its execution. The conflict arises almost wholly over the question of representation and questions of enforcement. The employer in some industries denies the right of men other than his own employees to conduct the negotiations. Labor organizations demand that, as such negotiations require skill, experience and bargaining freedom, they are of more than local application and that thus they can only protect the body of workers by presenting the case on their behalf by skilled negotiators.

The Second Industrial Conference, of which I was a member, proposed a solution to this point by the provision that where there was a conflict over representation the determination should be left to a third and independent party. It also proposed that each party should have the right to summon skill and experience to its assistance. It further proposed that where one of the parties at dispute refuses to enter upon collective bargaining the entire question should be referred to an independent tribunal for investigation as to the right and wrong of the whole dispute—but only for investigation and report. That conference, embracing both a great employer and a most distinguished representative of organized labor, was completely convinced that the illumination of the public mind as to the rights and wrongs of these contentions would in itself make for material progress in their solution, and that in public education and the condemnation of public opinion of wrongdoing lay the root to real progress. No group should be afraid of authoritative publicity in these matters, and I believe it would greatly advance an understanding of the cause of labor. The conference did not believe that industrial contention could be cured by compulsory arbitration or any other form of governmental repression which must in the end use the jails for enforcement. The principles formulated by that conference should have your consideration.

Employer and Employee

There are questions in connection with this entire problem of employer and employee relationship, both in its aspects of increased production and in its aspects of wasteful unemployment, that deserve most careful study by our engineers. There lies at the heart of all these questions the great human conception that this is a community working for the benefit of its human members, not for the benefit of its machines or to aggrandize individuals; that if we would build up character and abilities and standard of living in our people we must have regard to their leisure for citizenship, for recreation and for family life. These considerations, together with protection against strain, must be the fundamentals of determination of hours of labor. These factors being first protected the maximum production of the country should become the dominating purpose. The precise hours of labor should and will vary with the varying conditions of trades and establishments, but the proper determination of hours, based upon these factors, is an immediate field demanding attention of engineers.

There is a broad question bearing upon stimulation of self-interest and thus increase in production that revolves around the method of wage payment. I need not review to you the advantages, difficulties and weaknesses of bonus, piece work, profit-sharing and saving plans that are in use as a remedy for the deadening results of the same wage payment to good and bad skill alike. The suggestion I wish to put for your consideration is the possible use of another device in encouragement of individual interest and effort by creating two or three levels of wage in agreements for each trade, the position of each man in such scale to be based upon comparative skill and character. This plan should be developed upon the principle of graded extra compensation for added skill and performance above an agreed basic wage.

We must take account of the tendencies of our present repetitive industries to eliminate the creative instinct in its workers, to narrow their field of craftsmanship, to discard entirely the contribution to industry that could be had from their minds as well as from their hands. Indeed, if we are to secure the development of our people, we cannot permit the dulling of these sensibilities. Indeed, we cannot accomplish increased production without their stimulation. Here again we cannot make an advance unless we can secure co-operation between the employer and the employee. In large industries this mutuality of interest that existed in small units cannot be restored without definite organization.

Shop Committees

There has been a great increase in shop committees as a method of such organization. Where they have been elected by free and secret ballot among the workers, where they are dominated by a genuine desire on both sides for mutual co-operation in the shop, they have resulted in great good. One of the most important phases of that good has been the tendency to turn the aspect of some foremen from that of slave-driving to leadership. And a great good has been possible by the encouragement of men to creative effort in the stimulation of their minds as well as their hands to the solution of these problems. It makes for pride of craftsmanship and is a real effort to offer them an opportuity of self-expression. Organized labor

has opposed some forms of these committees because of the fear that they may break down trade organization covering the area of many different shops. There is economic reason for this fear in certain cases deeper than appears upon the surface. One of the greatest accomplishments of organized labor has been the protection of the workers from the unfair employer, and it is worth the employer's notice that this is at the same time the protection of the fair employer from the unfair competition of the sweat shop. Again I believe the engineers could assist in the erection of a bridge of co-operation if organized labor, which has already made a beginning, would extend more widely its adoption of the principles of the shop committee settling its problems of wage and conditions of labor in general agreement and applying its energies through shop committee organization to development of production as well as to the correction of incidental grievance. There would be little outcry against the closed shop if it were closed in order to secure unity of purpose in constructive increase of production by offering to the employer the full value of the worker's mind and effort as well as his hands.

There is an immediate problem in increased production that is too often overlooked by the theorist. While it is easy to state that increased production will decrease cost and by providing a greater demand for goods secure increased consumption and ultimate greater employment, yet the early stages of this process do result in unemployment and great misery. It takes a variable period of time to create the increased area of consumption of cheapened commodities, and in the meantime when this is translated to the individual worker he sees his particular mate thrown out of employment. We accomplish these results over long periods of time, but if we would secure co-operation to accomplish them rapidly we must take account of this unemployment and we must say to them, the community, that if it is to benefit by the cheapening costs and thus the increased standard of living, or alternatively if the employer is to take the benefits, the entire burden should not be thrust upon the individual who now alone suffers from industrial changes. Nor can this be accomplished except by co-operation between groups. In fact, the whole problem of unemployment needs earnest consideration.

Summary

In summary, the main point that I wish to make is this: That there is a great area of common interest between the employer and the employee through the reduction of the great waste of voluntary and involuntary unemployment and in the increase of production. If we are to secure increased production and an increased standard of living we must keep awake interest in creation, in craftsmanship and *the contribution of the worker's intelligence to management.* Battle and destruction are a poor solution to these problems. The growing strength of national organizations on both sides should not and must not be contemplated as an alignment for battle. Battle quickly loses its rules of sportsmanship and adopts the rules of barbarism. These organizations—if our society is to go forward instead of backward—should be considered as the fortunate development of influential groups through which skill and mutual consideration can be assembled for co-operation to the solution of these questions. If we could secure this co-operation throughout all our economic groups we should have provided a new economic system, based neither on the capitalism of Adam Smith nor upon the socialism of Karl Marx. We should have provided a third alternative that preserves individual initiative that stimulates it through protection from domination. We should have given a priceless gift to the Twentieth Century.

I am not one of those who anticipate the solution of these things in a day. Durable human progress has not been founded on long strides. But in your position as a party of the third part to many of these conflicting economic groups, with your life-long training in quantitative thought, with your sole mental aspect of construction, you, the engineers, should be able to make contribution of those safe steps that make for real progress.

Letters to the Editor

The Writing of Engineering Reports

Sir—We have read with interest Prof. Mead's article on engineering reports (see *Engineering News-Record*, Nov. 4, p. 891), and we can add little to his admirable advice and detailed suggestions as to what a good engineering report should be. It only occurs to us to emphasize some general thoughts on the subject.

The great difficulty with many engineering reports is that their authors do not, or perhaps cannot, put themselves in the mental attitude of the client for whom the report is prepared.

The scope and character of the report as well as the art of presentation and the extent of appended facts and data all depend on whom the report is for, what use will be made of it, and how fully the client needs to be enlightened. Engineering reports are written primarily either for the public or their representatives, or for private owners, investors or promoters, or for technically trained minds, or for a combination of these classes. In any case they should adapt themselves to their proposed audience.

In investigating new projects or finding solutions for difficult problems it is almost always highly desirable for the engineer to present and estimate impartially all the reasonable methods of accomplishing the result and to discuss disinterestedly all the relative merits and objections of each method, and finally make his selection and recommendation only as a logical conclusion. This method enables the client to review all the accumulated facts, to get the engineering perspective of their relative importance, and to be in good position to see that engineering reasons in relation to outside economic considerations are given their proper weight. Properly presented it is a persuasive and convincing method of making an engineering report. Some few engineers fall into the temptation of deciding what they think is the best solution of a problem before they have collected or arranged the facts. Then of unfortunate necessity they must devote most of the report and cited facts to upholding the original contention.

Ideal engineering reports are in effect small court decisions. The evidence is first arranged, the arguments are presented, and finally an engineering judgment is rendered. Therefore the report should be so arranged that these separate functions are clear and distinct and not scattered or confused with each other. In presentation it is often desirable to reverse this order, but this should never mean that the original procedure is so conducted. It is of the highest importance that the author of a report should keep an open mind up to the moment of his final conclusion, and the report should bear internal evidence that he has done so.

It is always well to remember that the client has fully as much right to hear the evidence and alternatives and the reasoning which leads to a conclusion as the author of the report himself. A report so prepared is of the most convincing character. Reports of great length and laborious detail are seldom of interest or value except to technical men, or in the case of projects of great magnitude or importance.

What the client usually desires first is the conclusion of the engineer, tersely expressed in a few concise paragraphs and sustained in the body of the report by just enough simple convincing facts and proper comparisons to warrant the conclusions. Detailed technical analysis, if presented at all, should only be presented as an appendix. It goes without saying that simplicity of expression, avoidance of unnecessary technical terms, and use of ample illustration in the way of sketch plans, photographs, and simple maps, are most desirable and necessary in any concise report that aims to clearly present engineering problems to busy minds trained only in other directions.

Chicago, Nov. 15.

John W. Alvord,
Alvord & Burdick,
Consulting Engineers.

The Corps of Engineers and Our Public Works

Sir—In May, 1908, the writer discussed in *Engineering News* the relation of the Corps of Engineers to our public works. The editorial comment of 1908 on this discussion seems so pertinent to the present situation that it is worthy of repetition, including the appreciative paragraph concerning the fairness of the writer. It is as follows:

"We have never seen a fairer, more intelligent and more hopeful and helpful discussion of these questions than the letter printed above. We commend it to the careful study alike of the officers of the Corps of Engineers and of the civilian engineers who are interested in having the engineering work in connection with the coming expansion of waterway improvements placed on a better basis.

"As many of our readers know, agitation to have civilian engineers placed in control of river and harbor work dates back fully thirty years; but it has always failed and will always fail so long as it is construed by the public and by Congress as a mere quarrel between two branches of the profession, the civil and the military engineers, as to which shall have the authority.

"To be successful, appeal must be made not on behalf of the engineers but on behalf of proper, efficient and economical conduct of our great public works. There is no reason why the army engineers and the civil engineers should not join hands and work together for reforms in the conduct of our public works which will be of mutual benefit and, what is of far more importance, will place the planning and carrying out of our Federal public works on a basis calculated to better protect the public interests."

At the time of the publication of this article of 1908 the writer was serving under the Corps of Engineers as principal civilian engineer of the United States Lake Survey. His manuscript before submission to *Enigneering News* was placed in the hands of half a dozen engineer friends for comment. Comment indicated that such frank criticism of the corps would result in the decapitation of the critic; but it was published just the same—and the views expressed were followed by no reprisals.

Since that time some of the weaknesses of the corps have been eliminated. "Caste," or the exclusion in the personnel of everyone not of West Point, has disappeared. Men of other technical schools, Michigan, Boston Tech, Columbia or California, are working shoulder to shoulder with the honor men of the Military Academy. This infusion of other blood strengthens the stock and will ultimately add to the already high prestige of the corps. The problem of the civilian assistants is a difficult one, partially due to the long enervating effect of habitual subordination on the characters of the men themselves. Many good men still serve as assistant engineers with inadequate but permanent salaries and pensions ahead for their twilight years. The business and social relations of the officers and the civilians are in many cases cordial.

Let it be understood that the writer favors either a department of public works or an interdepartmental executive board of engineers, but does not approve the Jones-Reavis bill. Let it be further understood that with Herbert Hoover as Secretary of the Interior he believes reorganization will receive great impetus—and the dream of engineers for higher efficiency in our public works will be nearer realization.

The demand is now urgent for engineers to work out a really professional magnanimous organization of our federal engineering activities—as of today and tomorrow, with no reprisals for yesterday. The time is ripe for clear thinking without any jaundiced yellow infiltrations of old grudges or of interdepartmental or interprofessional jealousies.

The engineers of the country entered upon this reform in our public works administration as a crusade, a holy enterprise demanding fine courtesy, high ideals and immaculate motives. It was not intended as a predatory excursion—like the German advance on France—to dispossess one body of engineers for the gain of others. When the sinister predatory motive stands out clearly the crusaders cannot maintain the temperature of enthusiasm.

Has enthusiasm cooled? The report to Engineering Council on the Department of Public Works situation, as printed in *Engineering News-Record* of Oct. 28, is depressing enough with a clear statement as to the cooling of enthusiasm—and even rising opposition.

And this report makes it very clear that the issue is not primarily co-ordination of our federal engineering activities and therefore higher economy and efficiency with better protection to the public interests, but is the forty-year-old "quarrel between two branches of the profession, the civil and the military engineers, as to which shall have the authority." The Corps of Engineers in the report is referred to as our "adversary." Did the Germans use a similar term in the advance through Belgium?

If any churlish attitude has been evident in this campaign it should be pleaded in extenuation that the civil engineer is so tremendously virile and vigorous that he is sometimes ruthless, lacking such feminine qualities as courtesy and kindliness. That is the only possible defense. Is it sufficient?

The writer would like to extend this article beyond permissible limits in discussing the pettiness of this campaign against the corps and give a little testimony as to the human qualities, the engaging personality and the outstanding executive and engineering ability of some of the men of the corps he knows. He might with authority speak of what is fundamental in engineering education and show that certain things that are basic in engineering and in the conduct of life may be better taught at West Point than at many other technical schools. He might speak of the great ship lock at the "Soo" called the "Sabin Lock," after a civilian engineer there, and a government steamer called the "Alfred Noble." And the writer happens to know, as the world knows and all congressmen know, of certain engineering achievements which are properly viewed as the work of the corps.

In his inaugural address at Baltimore in June, 1914, Hunter McDonald as president of the American Society of Civil Engineers, spoke as follows:

"It is a matter of pride and cause for congratulation that the *most stupendous work of civilization*, the Panama Canal, is about to be presented to our government by *men of our profession*, completed greatly in advance of the time when it was due, and absolutely free from any taint of scandal, graft or incompetency in any of the stages of its progress."

Is it probable that with the echo of these words still ringing the corps will be dismissed as one might discharge an office boy?

Is it not possible to bring about a new larger co-ordinated administration of our federal engineering activities in which all that is sound, experienced, honest and capable is retained in the organization? Is it not time to forget that any group of engineers wished to oust the pre-eminent body of specialists in rivers, harbors and canals from this larger organization, or to retain them largely as spectators watching the master engineers operate?

In any new committee of the new council formed to carry on the work of higher co-ordination of our federal engineering work—which has been very helpfully advanced by the expiring committee—it would appear desirable to include some such men of the corps as Beach, Bixby, Jadwin, Judson, Keller, Langfitt, Newcomer, Patrick, Pope, Riché, Taylor or Townsend.

And civil engineers must think of these engineers of the corps, not as "adversaries," but as allies; because we surely wish a place in the sun of the distinction which the builders of the Panama Canal have conferred on all American engineers.

FRANCIS C. SHENEHON,
Consulting Hydraulic Engineer.

Minneapolis, Nov. 9.

Accidents Due to Neglect of Safety Orders

Of 758 industrial accidents in Wisconsin that were investigated by inspectors of the State Industrial Commission during the three months from July to September, 1920, it was found that 27 per cent were chargeable to violations of safety orders. The department also reports an increase as compared with last year's figures.

NEWS OF THE WEEK

New York, November 25, 1920

Federation, Under Hoover's Leadership, Plans Nation-Wide Industrial Survey

First Meeting of American Engineering Council Discusses Organization of Federated Societies and Chooses Washington for Headquarters

UNDER the leadership of Herbert Hoover, former food administrator and president of the American Institute of Mining and Metallurgical Engineers, who was elected to the presidency of the American Engineering Council, the governing body of the Federated American Engineering Societies, at the first meeting of that organization held in the Willard Hotel, Washington, D. C., Nov. 18-20, the federation is planning as one of its first activities in the interest of public service a nation-wide quantitative survey of industrial wastes, to include, among other special lines of inquiry, the aggregate loss to industry and to the public caused by strikes and lockouts intermittent employment and unemployment due to the shifting of industrial currents. Maintaining that the country's greatest problems today are those growing out of our industrial development Mr. Hoover, in his first address as president of the federation's Council, asserted that the engineer is the man best qualified to bring about co-operation among the country's great economic groups of special interests.

HERBERT HOOVER

The growing strength of national organizations of both employers and employees, he said, should not and must not be contemplated as an alignment for battle. These organizations, Mr. Hoover believes, should be considered as the development of influential groups through which skill and mutual consideration can be assembled for co-operation to the solution of our industrial problems. In their position as a party of the third part to many of these conflicting economic groups, Mr. Hoover pointed out, engineers, with lifelong training in quantitative thought and their sole mental aspect one of construction, should be able to make a contribution of those safe steps that make for real progress. His speech, in full, appears elsewhere in this issue.

TWENTY SOCIETIES REPRESENTED

The initial meeting of the American Engineering Council was attended by delegates from 20 of the 21 engineering organizations which have become charter members of the federation. The membership list includes 7 national organizations—the mechanical, electrical, mining and chemical societies, in addition to the Society of Industrial Engineers, the Taylor Society, and the American Society of Agricultural Engineers—and 14 state, city or regional bodies. In addition, representatives were present from other engineering organizations which are considering charter membership in the federation but which have not taken final action. The Kansas Engineering Society was the only member organization not represented by a delegate, but this organization was the first to make payment of its contribution as a charter member of the federation; its check was received by the treasurer on the morning of Nov. 19.

The Council sessions on Nov. 18 and 19 were devoted largely to organization, while on Nov. 20 the Executive Board of the Council held its first meeting. Committee reports formed the major part of the business transacted, there being only four addresses, the first, by Richard L. Humphrey, chairman of the Joint Conference Committee of Founder Societies, outlining the steps which had led to the creation of the Federated American Engineering Societies; the second, by J. Parke Channing, giving a résumé of Engineering Council's work; the third by L. W. Wallace, on factory management and labor, and the fourth by Herbert Hoover, discussing national industrial problems.

With about seventy-five delegates and guests in attendance, the first meeting of American Engineering Council was opened Nov. 18 by Mr. Humphrey, who reviewed the events leading up to the Organizing Conference in Washington June 4. By the assembling of delegates for the first meting of the American Engineering Council Mr. Humphrey believes that "the first step in realizing the dream of the engineering and allied technical professions for solidarity has been taken."

COMMITTEES NAMED

After the appointment of temporary officers—E. S. Carman, representing the American Society of Mechanical Engineers, as chairman, and W. E. Rolfe, of the Associated Engineering Societies of St. Louis, as secretary—the business meeting began. A resolution of regret that the American Society of Civil Engineers was not represented by delegates at the meeting was offered by Philip N. Moore and unanimously passed. The following chairmen of committees were selected: Program, J. V. W. Reynders, American Institute of Mining and Metallurgical Engineers. Credentials, J. F. Oberlin, Cleveland Engineering Society. Constitution and By-laws, C. F. Scott, American Institute of Electrical Engineers. Nominations, W. C. Powell, Engineering Society of Buffalo, N. Y. Plan and Scope, L. C. Nordmeyer, American Society of Mechanical Engineers. Budget, Calvert Townley, American Institute of Electrical Engineers. Resolutions, L. W. Wallace, Society of Industrial Engineers.

As a basis for the selection of members of the Executive Board of the council L. P. Alford presented a report suggesting the division of the United States into six districts from each of which a representative of the local member societies was to be selected. The Executive Board for the present will consist of the officers of the Council, 14 representatives from national societies and 6 representatives from local organizations. It was considered desirable not to elect the full number (30) authorized by the constitution, thus providing for representation of

(*Continued on p. 1062*)

Sliding Pittsburgh Hillside Covers Eight Pennsylvania R.R. Tracks

Fill Dumped on Steep Slope Below Bigelow Boulevard Causes Failure of Retaining Wall—Soil Flows Like Glacier

(Special report for Engineering News-Record by Morris Knowles and Maurice R. Scharff, Consulting Engineers, Pittsburgh.)

Burying eight tracks of the Pennsylvania R.R. under forty feet of dirt and threatening to cut in two its trunk line connecting Pittsburgh with the Atlantic seaboard, a great slide of filled ground on a steep hillside below and adjacent to Bigelow Boulevard, just east of the Union Station, Pittsburgh, has been in progress for the entire month past. The slide was started by the dumping of earth on the slope from street excavation near by, and has taken on progressively more serious form, up to the early part of this week, when the railroad forces engaged in digging away the base of the slide endeavoring to clear the tracks and prevent further encroachment of the flowing material were able to notice a slight gain. For nearly two weeks there has been imminent danger of complete interruption of traffic. Arrangements for abandoning the Union Station and diverting all traffic on the Panhandle and Fort Wayne lines of the Pennsylvania to a connection with the main line east of the slide have been made, so as to permit of maintaining operation whatever the outcome of the fight against the slide might be. General George W Goethals was appealed to by the city authorities of Pittsburgh late last week and inspected the slide on Saturday, Nov. 20. At last report (Nov. 22) the motion of the flowing mass on the slope had decreased. With continuing fair weather it is believed that no additional interference with the railroad operation need be expected. Long continued rains, however, might lead to very serious conditions.

Improvement of Bigelow Boulevard, a main thoroughfare from downtown to the east end, part of Lincoln Highway from Pittsburgh east, was started some months ago, the main operation being the construction of a retaining wall on the uphill side for a length of about one-half mile to widen the road and prevent fall of hillside material onto the roadway. At the same time a curve in the boulevard farther east, where the original alignment was bent into the hillside at a natural hollow, was being straightened by dumping the excavation spoil on the slope below the boulevard. This filling process started the slide.

PITTSBURGH SLIDE, LOOKING DOWN FROM BIGELOW BOULEVARD TO PENNSYLVANIA R.R. TRACKS; UNION STATION TO LEFT OF VIEW

The portion of the boulevard near Kirkpatrick St., built in 1898, is located on a curve following the hill contour near the top of a deep gully known as Jones' Hollow, leading down to the Pennsylvania R.R. roadbed. At that time an ashlar masonry wall was constructed at the foot of the hollow and the hollow partly filled with material wasted from the cuts on the boulevard construction. During the progress of this filling the wall cracked and moved several inches; further deposition of material was then stopped, and the motion of the wall was checked by proper drainage. A rock-filled wooden crib at the foot of the slope was built up to take the pressure of the further filling necessary to support the boulevard roadway.

Since that time the city's highway maintenance department has dumped street cleanings and other material on top of the old fill. About three months ago additional filling on top of the old bank was commenced, in order to utilize the excavation at the site of the new retaining wall farther west for flattening the curve at the hollow in order to better the alignment of the boulevard.

On Oct. 29 the old masonry retaining wall at the foot of the hollow failed. The new and old fills together started moving. Part of the boulevard just above the hollow showed depression of the pavement and cracks, a city stable located on the fill was destroyed, and a large brick stable above the boulevard at the upper limit of the 1899 fill was cracked.

How Slide Acted

The slide in its further progress developed a typical glacial flow form, showing successive waves and hollows, and moved out over the Pennsylvania R.R. tracks (note arrow A on photograph herewith). Immediately two steam shovels were put to work by the railroad forces. Within four days nine shovels and two ditching machines were attacking both flanks of the slide. This process of removing the material at the foot of the slide with utmost rapidity has continued since then.

Tracks located at and in front of the slide have been raised in some cases as much as 10 ft. and have been repeatedly destroyed. It has been necessary to pull shovels out and rebuild tracks again and again. The nose of the slide, originally about 45 ft. high, has now (Nov. 22) settled about 10 ft. through effect of removal of material.

Eight tracks up to and including that marked by arrow B in the view have been put out of commission, and although two tracks have been partly restored eleven tracks in all have been taken from normal railroad use when those used for loading and shifting dirt cars are included (up to arrow C in photograph), leaving only eight tracks for traffic of the system east of Pittsburgh. Material is being hauled away in 51 Clark dump cars of 30-yd. capacity and 300 wooden dump cars of 12 to 16-yd. capacity; in addition many trains of 50-yd. gondolas have been loaded. Eight locomotive cranes with clamshell buckets are at work unloading cars at the points of disposal at Derry and Donahoe on the main line, Edgeworth on the Fort Wayne, and Mingo Junction on the Panhandle. The shovels working at the base of the slide have a total capacity of 30,000 cu.yd. per day, but have averaged only 6,000 and 7,000 cu.yd., due to the necessity of compromising with train operation. The total removal to date has been 70,000 to 80,000 cu.yd., with several times this amount still to be removed.

When the retaining wall failed a large section of it wrecked part of a two-story brick inspection and supply building 30 x 220 ft. at the foot of the slope, and with the continuance of the slide it has been necessary to pull down additional portions to prevent the falling of walls, so that a 160-ft. length of the original building has been completely destroyed, leaving only a 60-ft. length standing (arrow D on photograph).

In the inspection of the slide made by General Goethals on Nov. 20 no changes in the method of dealing with the slide developed. No formal statement was given out, but General Goethals will submit a written report to the mayor. He is quoted by newspapers as approving the present program of removing the material as fast as it comes down and as advising that nothing further be done except to continue surveys, borings, and investigations until all material has reached equilibrium up to the most remote cracks.

Shovels Gaining

Motion of the slide material has decreased at the date of writing and the shovels are gaining on the slide. All connected with the work feel confident that additional interference with the operation of the railroad is unlikely unless long rains set in. Plans are complete for detouring all traffic if necessary.

Rerouting of cars on the street railway system in order to handle the traffic diverted from the railroad and conversion of Forbes St. and Fifth Ave. into one-way streets are being considered; these two streets are main thoroughfares to the east end of the city.

Discussion of responsibility for the slide among the city authorities has been very active during the past week. The whole case will throw a heavy cost on both the city and the railroad, and the council has ordered a thorough investigation.

C. W. Richey, division engineer of the Pittsburgh Terminal Division, is in charge of work at the slide for the railroad, under W. D. Wiggins, chief engineer of the Central Region, Pennsylvania R.R. N. S. Sprague, chief of the Bureau of Engineering, and John Swan, director of public works, are in charge of the work for the city of Pittsburgh.

Am. Soc. C. E. Wants Engineer on Commerce Commission

The board of direction of the American Society of Civil Engineers on Nov. 9 appointed a committee composed of Charles Hansell, James L. Tighe, Edward H. Lee, Charles S. Churchill and Samuel Murray to take up with the appropriate committee of Engineering Council and with committees of other engineering societies the initiation of such action as may be proper to have an engineer appointed on the Interstate Commerce Commission.

New York Engineers Discuss Rapid Transit

Second Meeting of Am. Soc. C. E. Local Section Considers Broad Metropolitan Plan

New York's rapid transit problem—considered from the standpoint of the metropolitan district as a whole—was discussed at the second meeting of the season of the New York Section of the American Society of Civil Engineers, Nov. 17. The principal paper, "Urban and Suburban Transportaton in the Metropolitan District of New York," was presented by Henry M. Brinckerhoff, consulting engineer, of the firm of Parsons, Klapp, Brinckerhoff & Douglas, who proposed a plan for a unified rapid transit system which would not only serve the five boroughs of New York City but also the New Jersey metropolitan district by river tunnel connection. An abstract of Mr. Brinckerhoff's paper appears elsewhere in this issue. Other authorities on rapid transit joined the discussion, which brought out almost unanimous sentiment among engineers against municipal operation, but favoring consideration of the problem not only from the New York City viewpoint but also from the viewpoint of the metropolitan district as a whole.

Frank Hedley, president and general manager, Interborough Rapid Transit Co., New York, characterized Mr. Brinckerhoff's plan as "an engineer's dream," saying that it would be extremely difficult to carry out in practice since the City of New York has already used a substantial amount of its credit to build subway lines and would not be willing to extend its credit to help build up territory in New Jersey. Mr. Hedley said that the need was for immediate new construction to extend present rapid transit lines in New York City, and that the recent report of the Rapid Transit Construction Commission covering proposed extensions for the next twenty-five years was very much belated because a substantial part of the new lines should now be under construction.

The plan of the Rapid Transit Commission was outlined by its chief engineer, D. L. Turner, who prepared the report. It was explained that for the purposes for which the report was prepared it was impossible to give consideration to the extension of rapid transit lines by river tunneling into New Jersey. Mr. Turner considered rapid transit a municipal function, not a business proposition, but emphasized that the great problem was one of finance. He suggested that increased realty values resulting from extension of rapid transit lines be assessed, ultimately to pay for new construction rather than increasing fares. J. Vipond Davies, of Jacobs & Davies, consulting engineers, New York, questioned the advisability of extensive additions to present rapid transit construction that would materially increase present congestion in the downtown district of Manhattan. To this end it might be better to foster the development of community centers in New Jersey to reduce the volume of transportation.

Tribute to Engineers

A tribute was paid to the work of engineers in developing New York's rapid transit system by George McAneny, president of the Board of Aldermen during the Mitchel administration. He said that the existence of a metropolitan section extending into New Jersey should be recognized and that there was need for the preparation of a universal plan far in advance of requirements. Mr. McAneny asked the question, "Why should not the two states come together on the rapid transit question?" In the meantime he said that there should be no let up in the program of New York City extensions, but characterized a comprehensive rapid transit development as "infinitely difficult to finance."

Delos F. Wilcox, public utilities expert and a member of the Federal Electric Railway Commission, favored public operation (on the assumption of public ownership), saying that such a matter as rapid transit was a public function, that it was difficult to regulate, and that instead of the service-at-cost plan a much simpler way to effect practically the same results would be through public operation, and that communities should be assured against strikes. The present difficulty, said Mr. Wilcox, is that the public will not permit the necessary return on investment to insure success of private operation.

The steam railroads were represented by R. S. Parsons, general manager, Erie Railroad Co.; P. H. Woodward, general passenger agent, Long Island R.R., and George A. Harwood, assistant to the president, New York Central Lines. Mr. Parsons stated that suburban transportation in the metropolitan district had now reached such proportions that it is no longer profitable, due to the necessity of extending facilities from the time when the suburban transportation required but a small portion of the present plant. He outlined the plan for a proposed suburban passenger terminal to be used jointly by the railroads in New Jersey, which would be connected through a tunnel under Jersey City Heights and the Hudson River, with a moving sidewalk to Manhattan. Mr. Parsons also suggested the need for bridging the Hudson River, and said he thought it "a reflection against members of this society that a bridge is not already being built across the Hudson." Mr. Woodward of the Long Island looked for the greatest increase in population in the Borough of Queens, and said that the single present trunk line must have help from additional rapid transit facilities. He said that no matter how large present plans may be they will not be large enough in twenty-five years. Mr. Harwood of the New York Central outlined the history of local steam road transit from the beginning

of operation on the Harlem R.R. in 1832. He suggested a transfer point at Mott Haven to connect with rapid transit lines entering Manhattan and said that the present steam railroad suburban traffic was unprofitable.

CROSS TRANSFER ROUTES

Frank J. Sprague, introduced as the "father of rapid transit," said that he was in entire accord with Mr. Brinckerhoff's view, and that a restricted plan would fail. He characterized the present plan as abortive, and said that the need was for cross transfer routes as well as the longitudinal system. The financial aspect of the subject was discussed by O. B. Wilcox, vice-president, Bonbright & Co., New York City, who emphasized the importance of security of principal and interest to investors in rapid transit projects. He said that private operation was successful except for the refusal of the public to permit an adequate return. He did not favor further congestion in downtown Manhattan.

A paper by L. B. Stillwell, consulting electrical engineer, New York City, was read by Colonel F. A. Molitor, citing the development of rapid transit in New York City as the engineer's accomplishment. Mr. Stillwell wrote that the moving platform today occupies about the same position as the proposition of electric traction did twenty years ago. A moving platform with a speed of 12 miles per hour as had been proposed would give three times the capacity of a subway route for the shorter hauls.

The meeting was presided over by Colonel W. J. Wilgus, president of the section. Colonel Wilgus announced that it was the intention, as a result of the series of eight discussions on engineering problems that affect the future of the metropolitan district, to refer these discussions to committees for the purpose of making reports and recommendations looking to the solution of each of the problems with a view to developing a comprehensive metropolitan plan. He proposed that the studies and conclusions be published in report form after the close of the season's meetings. The next meeting of the section will be devoted to consideration of "The Port of New York," Dec. 15. A report of the first meeting of the section, which was devoted to the local freight-handling problem of the metropolitan district, appeared in *Engineering News-Record*, Oct. 28, 1920, p. 865.

Immense Majority for New Jersey Bridge and Tunnel Bonds

The vote Nov. 2 on the $28,000,000 New Jersey State bond issue toward the cost of the Hudson River vehicular tunnel and the bridge over the Delaware River between Camden and Philadelphia was approximately 569,000 to 95,000 or nearly 6 to 1 in favor of the bonds. Every county in the state gave a good majority for the bonds.

Salem Water-Borne Typhoid Epidemic Declining

Some 800 Cases in Ohio City Due to Leaky Vitrified Clay Conduit—Preventive Measures

The typhoid epidemic at Salem, Ohio, noted in our issue of Nov. 18, p. 1012, according to a letter to this journal from W. H. Dittoe, chief engineer Ohio State Department of Health, is still believed to be due to pollution of the water-supply, although no final conclusion has been reached. Up to Nov. 19, Mr. Dittoe states, 763 cases had been investigated by the department, which is thought to be practically all the cases that had occurred. The peak of the outbreak was reached Nov. 1, when 54 cases were plotted on the "took to bed" chart. Since then the "to bed" curve has shown a rapid decline. The deaths to Nov. 19 had been ten, of which the latest was on Nov. 14. The following summary of the sanitary engineering activities undertaken to prevent the spread of the disease, not only in Salem, but down the river in both Ohio and West Virginia, is taken from Mr. Dittoe's letter of Nov. 19 to *Engineering News-Record*:

1. Chlorination of the public water supply was started Oct. 20 and is still in use. Also printed notices warning citizens to boil all water, whether from the public mains or from private wells, have been distributed and posted in prominent places. Also regular analyses of the water supply have been made since chlorination was started and these have shown freedom from contamination.

2. While no definite conclusion has been drawn, it appears likely that contamination reached the water from a gravity line of vitrified clay pipe conveying the water supply and since Oct. 27, this line has not been in use.

3. The usual disinfection of stools from typhoid patients has been rigidly practiced.

4. To prevent the use of dangerous dug wells on properties which are served by the public supply we have undertaken disinfection of such wells by introducing 2 lb. of chloride of lime.

5. In an effort to prevent spread of infection we have undertaken disinfection of all vaults by the application of 5 lb. of chloride of lime.

6. To prevent as far as possible the contamination of the stream receiving the partially treated sewage of the city, we have placed in operation a chlorinating machine applying chlorine gas to the tank effluent.

7. To avoid as far as may be the spread of infection to communities down stream from the city, we have notified the upper Ohio River cities in Ohio, also the West Virginia State Health Department regarding the occurrence of the epidemic, advising the boiling of water for those cities which use the river water without filtration and advising extreme care in the operation of filtration plants, also arrangements have been made to notify village and township officials in the territory between Salem and the Ohio River.

8. Requirements have been imposed that all milk delivered in the city shall be efficiently pasteurized. Also orders have been made to prevent the leaving of milk bottles at places where typhoid fever exists. Tradesmen are also prohibited from delivering milk over counters in bottles.

New Motor Taxes in England

The new automobile and motor truck taxes which have been under discussion in Great Britain and which substitute a horsepower and weight basis of taxation for the gasoline tax now in use, will become effective Jan. 1, 1921. These taxes were given in detail in the *Engineering News-Record* of July 1.

Am. Soc. C. E. Committees to Study External Relations

At its meeting Nov. 9 the board of direction of the American Society of Civil Engineers appointed two committees to consider the external relations of the society, the action being due to the negative vote upon entrance into the federation and the positive vote in the April questionnaire, regarding active co-operation with other engineers and allied technical associations in promoting the welfare of the engineering profession.

The first committee is composed of corporate members whose duty it will be to consider and make recommendations "for determining and governing" the relations of the society to other engineering bodies. It is understood that the idea in mind was to appoint younger members of the society on this committee. There are two representatives of District 1 and one from each of the other districts. They are: R. C. Marshall, Jr., chairman; W. T. Chevalier, George A. Johnson, Ralph W. Horne, Charles A. Poole, Edgar M. Hoopes, Jr., Kenneth C. Grant, J. H. Dunlap, W. D. Gerber, W. J. Burton, John S. Means, S. B. Morris, Fred M. Randlett, C. H. Snyder.

The second committee will consist of all living past presidents of the society, and its duty will be to review and transmit to the board the report of the committee of corporate members above referred to. The first committee is to finish its work by Jan. 1 and the second committee then will have until Jan. 17 (the next regular meeting of the board) to prepare and submit to the board its commentary on the first committee's report.

As a necessary incident to the close of the matters bearing on the federation the conference committee was ordered to submit its final report not later than Nov. 20, when it was to be discharged.

At the same meeting the board also passed a resolution the closing paragraphs of which are as follows:

"Be it resolved, that the Board of Direction hereby instructs its representatives upon Engineering Council to state to Engineering Council that they cannot participate in any action by Engineering Council in transferring its activities to the Federated American Engineering Societies.

"Be it further resolved, that the Board instructs its representatives to express to the council its hope that Engineering Council will, for the present, continue to carry forward its work."

Nobel Prize for Physics Awarded

Discoveries in the field of nickel and steel alloys by Edouard Breteuil, head of the International Bureau of Weights and Measures, have brought to him the award of Nobel prize in physics for the year 1920 by the Swedish Academy of Science.

Panama Canal Surplus, $2,387,599

The sixth and best year of operation of the Panama Canal, ended June 30, 1920, shows a revenue of $2,387,599 in excess of the expenses for operation and maintenance, and thus reduced the deficit of the six-year period to $2,231,091, according to the recently issued annual report of Brigadier General Harding, U. S. A., Governor of the canal. For the year 1919-1920 the revenues were $8,935,871, as against expenses of $6,548,272. For dredging the expense was $1,611,359, an excess of about $500,000 over the previous year owing to the slides in the Gaillard cut. The report states that the motion of the slides has been much retarded and that a new period of stability is approaching. The number of vessels passed was 2,745, of which 2,478 were in commercial service. Governor Harding predicts that within a reasonable period of normal world conditions the canal will earn an actual profit on its construction cost of $366,650,000, this sum being exclusive of the expense for military and naval defense.

Separating the Mississippi and Atchafalaya Rivers

Partial closing of the connection between the Mississippi River and the Atchafalaya River, in Louisiana, by narrowing the present seven-mile gap in the levee system south of Point Breeze, is advocated in a resolution passed at a recent meeting of representatives of the federal and state governments and of landowners and property interests along the two rivers. Advocates of complete separation of the two rivers were unable to secure the endorsement of so radical a step, but the resolution as passed urges a further study of the question. Separation of these two rivers by closing the present connection through the old river channel, so that the Atchafalaya will no longer serve as a relief for Mississippi River floods, has been advocated for many years but is opposed by those who foresee serious effects of an increased flood stage in the Mississippi.

In the opinion of the Corps of Engineers, U. S. Army, the problem has been studied so thoroughly that nothing is to be gained by further study. The Atchafalaya basin can be protected against flood by levees, but this would be a very costly project. On the other hand, the closing of the present outlet would increase seriously the engineering problem of caring for the mouth of the Mississippi, owing to the increased amount of silt brought down. Further, the separation would so increase the flood stage as to necessitate raising the levees south of the Atchafalaya connection, and would also constitute an additional potential danger to the city of New Orleans. It is considered by some engineers that the raising of the levees and the work at the mouth of the Mississippi would involve greater expenditure than the construction of levees along the Atchafalaya.

Cleveland Clearwater Basin Suit Decided

City's Claim for Cost of Rebuilding Rejected — Findings of Master Upheld — Important Case in Contract Law

Terminating long litigation involving important new points in contract law, a decision rendered by Federal Judge Westenhaver at Cleveland Nov. 15 in the case of the West Side clearwater basin construction awards $38,879 to the Walsh Construction Co. and $20,932 to the city of Cleveland, so that the city now owes the contractor $18,000 in final settlement. The decision in its money awards apparently follows closely the findings of fact reached by Robert Hoffmann, chief engineer of the city's Department of Public Service, who was appointed by the court a special master commissioner to report on the issues in dispute.

Comparison with the figures set out in the master's report indicates that the decision, whose precise terms are not yet available, makes award to the contractor for (1) unpaid balance on work performed, (2) extras definitely ordered by the city, (3) additional cost of a conduit on account of leakage from the city's pipes and sewers into the trench, and (4) costs arising from a change in plan for part of the construction. It disallows the contractor's claims for more difficult work due to sliding of the hillside south of the basin, and for complications arising from the presence of a track on the site, existing when the contract was let but not shown on the plans.

On the same basis of comparison the city is awarded (1) liquidated damages for delay in completion, computed after accounting for various delays due to the city's own actions, and (2) damages of about $14,000 for defective concrete, this amount being computed from the yardage of such concrete determined from the testimony, at the contract prices per yard for the several classes of concrete in the structure.

Two major factors in the suit were decided against the city. By far the largest in amount of money involved was the city's claim that the complete reconstruction of the basin by jacketing it with reinforced concrete, carried out after a section of roof of the basin collapsed within a few months of completion of the original contract, should be charged against Walsh, contractor for the basin as first designed. The price paid for this reconstruction was $328,000, whereas the contract price for the basin as originally designed was about $272,000. The master found that the reconstructed basin is functionally different from the original structure, and that many defects in the original structure were due to the design, for which the contractor was not responsible. Tipping of the north wall due to inadequate foundation, and cracking of the basin structure, were among the defects discussed in this connection. The city's claim for reimbursement for the cost of reconstruction was disallowed.

An important question, though involving a smaller amount, hinged on the fact that the sum due the contractor for work done under the contract and ordered extras, at the bid unit prices, exceeded the sum certified by the city's Director of Finance by endorsement on the contract as available for the work. According to the master's findings the failure of the financial authorities to certify additional sums limits the contractor's claim to the amount certified, and he is held responsible for payments already made in excess of this sum. It appears however that the judge reversed this finding by allowing the full claim of the contractor for unpaid balance, and that on the other hand he reinstated the city's claim for liquidated damages for delayed completion, which had been disallowed by the master in consideration of automatic termination of the contract before its final completion.

A minor element of the case was the city's long delay in acceptance of the completed work. It was found that this delay was unwarranted, and a limiting date on which acceptance should have been made by the city was fixed in the findings.

The original contract for the basin was executed on March 29, 1915, and work was completed before the end of that year. On July 9, 1916, a section of the basin roof collapsed because of the presence of honeycombs in columns supporting this section. Reconstruction by jacketing with reinforced concrete was carried out in the following year.

The Walsh company then sued the city for about $40,000 on unpaid balance and other claims, and the city in reply made counterclaim for a sum in excess of $330,000. The court with the consent of the parties appointed Mr. Hoffmann master to hear the case; testimony was taken by him during seven months of 1919, and his report was rendered in December of that year, since which time the case has been in the hands of the court.

A fuller review of the case will probably be published when the text of the court decision becomes available.

Lowest Death Rate Ever Recorded in Registration Area

The lowest death rate ever recorded for the registration area of the United States is reported for 1919 by the Census Bureau. The rate is 12.9 per 1,000, compared to 18 per 1,000 for 1918, the year of the influenza pandemic. The total number of deaths recorded for 1919 is 1,096,436 in a total estimated population of 85,147,882, in 33 registration states, the District of Columbia and 18 registration cities in non-registration states. (See *Engineering News-Record*, April 8, 1920, p. 732, for map showing registration area.)

Federated Societies Meeting

(*Continued from p. 1057*)

organizations which may join the federation prior to July 1, 1921. The following six districts were approved: District 1, New England States and New York; District 2, Michigan, Wisconsin and Minnesota; District 3, Ohio, Indiana and Illinois; District 4, New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia; District 5, Southern States, including Louisiana and Texas; District 6, Pacific Coast States and others not included in the foregoing five districts.

Figured on a membership basis the national organizations are entitled to the following representation: Chemical engineers, 1; electrical engineers, 4; mining engineers, 3; agricultural engineers, 1; mechanical engineers, 4; industrial engineers, 1; Taylor Society, 1.

Executive Board Chosen

The following were named as members of the Executive Board: For the American Institute of Mining and Metallurgical Engineers, Edwin Ludlow, Arthur S. Dwight and Philip N. Moore. American Society of Mechanical Engineers, L. P. Alford, E. S. Carman, Arthur M. Greene, Jr., and Fred J. Miller. American Institute of Electrical Engineers, H. W. Buck, William McClellan, Charles F. Scott and Lewis B. Stillwell. American Institute of Chemical Engineers, Harrison E. Howe. American Society of Agricultural Engineers, Samuel H. McCrory. Society of Industrial Engineers, L. W. Wallace. Taylor Society, Morris L. Cooke.

For the local organizations the following members of the Executive Board were selected: District 1, W. B. Powell, Engineering Society of Buffalo, N. Y., or Bion E. White, Mohawk Valley Engineers Club, Utica, N. Y.; District 2, C. A. Parks, Grand Rapids (Mich.) Engineering Society, or D. J. Sterrett, Detroit Engineering Society; District 3, J. F. Oberlin, Cleveland Engineering Society; District 4, W. W. Varney, Engineers Club of Baltimore; District 5, O. H. Koch, Technical Club of Dallas, Tex.; District 6, L. B. Smith, Kansas Engineering Society.

Action was taken whereby the date for becoming a charter member of the federation for all those organizations which were invited to the Organizing Conference last June has been extended to July 21, 1921.

Headquarters at Washington

The location of the headquarters of the Council was a subject which elicited lively discussion. The contest eventually narrowed down to New York or Washington. Strong pleas for Washington were made by Philip N. Moore, of the mining engineers, and others. Calvert Townley argued in favor of a location other than Washington because of the danger, as he saw it, of the organization "being drawn into a political vortex." While many of the speakers conceded decided advantages, from the business standpoint, in a New York headquarters, it was pointed out that the establishment of headquarters in New York City would be construed, especially by local organizations in the Middle West and South, as a move to have the federation's policies dominated by the East. It was apparent, however, that sentiment was swinging toward Washington and when the vote was taken Washington was chosen by a vote of 29 to 6.

Hoover Accepts Presidency

The report of the nominating committee was made at the morning session Nov. 19, and the following officers of the American Enginering Council were unanimously elected: President, Herbert Hoover, American Institute of Mining and Metallurgical Engineers; vice-presidents, Calvert Townley, American Institute of Electrical Engineers, W. E. Rolfe, Associated Engineering Societies of St. Louis, Dexter S. Kimball, American Society of Mechanical Engineers, J. Parke Channing, American Institute of Mining and Metallurgical Engineers; treasurer, L. W. Wallace, Society of Industrial Engineers.

In accepting the presidency Mr. Hoover expressed his willingness to fill "any position which might render service to the engineering profession." He believes in a consolidation of engineer effort, not only in technical work but in civic and economic affairs, where the engineer's voice should be heard throughout the community. There has never been a time, said Mr. Hoover, when we needed more urgently than at present the engineer's kind of thinking.

Committee Reports

Constitution and By-laws. — Only minor changes in the printed constitution and by-laws of the federation were proposed by Prof. Scott, chairman. The title of the secretary was changed from "Executive Officer" to "Executive Secretary," and the meetings of the Executive Board made bimonthly, except during July and August, instead of monthly. Contributions of member societies are to be payable in advance quarterly, instead of semi-annually. A number of changes were suggested in the chapter of the by-laws relating to publicity, but after a lengthy discussion the charter was approved as originally drafted, and reads as follows: "The privilege of attendance at all meetings of the American Engineering Council, of the Executive Board and Committees, when not in executive session, shall be extended to any proper person, but this privilege does not include the right to speak or vote. Any proper person shall have the right to inspect and make true copies of the official records of all meetings of the Council, the Executive Board and committees."

Plan and Scope.—One of the most fruitful and important fields of endeavor for the federation, according to L. C. Nordmeyer, chairman, lies in contact with governmental legislation and the rendering of service in an advisory capacity to the end that sound engineering principles may be adhered to. The method of procedure of the original Engineering Council, whereby various subjects were handled through standing or special committees whose membership was composed of men best qualified to deal with specific subjects, regardless of whether they were members of the Council or not, was endorsed. Among the subjects on which it was suggested that the federation might take action are the following:

1. Serving the public interest by investigation and advice to the public and to governmental and voluntary bodies upon national problems which involve industrial and economic questions.
2. National Department of Public Works.
3. Conservation of natural resources, such as water, coal, oil, etc.
4. Maintenance of co-operative attitude toward other national organizations, both professional and commercial.
5. Technical education.
6. Transportation in its various forms, particularly highways.
7. Advice with and assistance to regional, state and local organizations upon their request.
8. National Bureau of Economic Research.
9. Public fire prevention.
10. Patents.
11. National Board of Jurisdictional Awards.
12. International affiliation of engineers.
13. State organizations of local affiliation.
14. Uniform licensing and registration laws.
15. Classification and compensation of engineers.
16. Bureau of employment.
17. Russian-American Engineers Committee.

The committee report concluded with this statement of principle: "Every care should be exercised to avoid any action partaking of political bias or partisanship, and to keep the activities and pronouncements of the Federated American Engineering Societies within the pale of sound engineering, good judgment and upon the broad basis of a real and mutual co-operation."

Budget.—Two estimates of income and expenses were made by the committee on budget, Calvert Townley, chairman. The first, or "minimum assumption," was based on an ultimate membership for the year of only those societies which had already definitely joined. The other, or "maximum assumption," included all present member societies and nine "participating" organizations, many of which were represented at the Council meeting but which had not taken definite action. The minimum assumption, on the foregoing basis, would provide a yearly revenue of $59,000, while the maximum assumption would yield $80,000. On the same basis minimum and maximum expenditures were estimated at $56,500 and $92,500, the latter figure covering more elaborate plans than it will be feasible to carry out at present.

Executive Board Meeting

At the first meeting of the Executive Board of the Council, held Nov. 20, the following committee was named to re-

port a list of qualified candidates for the position of Executive Secretary of the Council: Messrs. Wallace, Moore, Scott, Oberlin, Alford and Townley.

RESOLUTIONS OF BOARD

On motion of Mr. Miller the Executive Board endorsed the plan of Mr. Hoover for an investigation of industrial wastes and authorized him to form an organization for that purpose.

The Board also approved a resolution, offered by Mr. Moore, which read: "Resolved, that this Board recognizes the great importance and value of the movement to secure the establishment of a National Department of Public Works, as initiated by Engineering Council and continued by the National Public Works Department Association, and that the Board declares itself in favor of continuing efforts toward that end."

L. P. Alford was appointed temporary secretary of the Executive Board to serve until its next meeting.

While it did not come officially before the Executive Board, a resolution passed by the American Society of Civil Engineers' Board of Direction at its meeting of Nov. 9, whereby the society forbids its representatives on Engineering Council to transfer the activities of that body to the Federated American Engineering Societies and expresses the hope that the old Engineering Council will "for the present continue to carry forward its work" was the subject of considerable discussion. It appears to be the purpose of the other three founder societies to withdraw from Engineering Council on or before Dec. 31, 1920, utilizing the new machinery of the federation for carrying on and enlarging the former work.

Membership of the Federated American Engineering Societies, Nov. 20, 1920

Alabama Technical Association, Birmingham, Ala.
American Institute of Chemical Engineers, Brooklyn, N. Y.
American Institute of Electrical Engineers, New York, N. Y.
American Institute of Mining and Metallurgical Engineers, New York, N. Y.
American Society of Agricultural Engineers, Ames, Iowa.
American Society of Mechanical Engineers, New York, N. Y.
Associated Engineering Societies of St. Louis, Mo.
Detroit Engineering Society, Detroit, Mich.
Engineering Association of Nashville, Tenn.
Engineering Society of Buffalo, N. Y.
Grand Rapids Engineering Society, Grand Rapids, Mich.
Kansas Engineering Society, Topeka, Kan.
Louisiana Engineering Society, New Orleans, La.
Mohawk Valley Engineers' Club, Utica, N. Y.
Technical Club of Dallas, Tex.
The Cleveland Engineering Society, Cleveland, Ohio.
The Engineers' Club of Baltimore, Md.
The Society of Industrial Engineers, Chicago, Ill.
Washington Society of Engineers, Washington, D. C.
York Engineering Society, York, Pa.
Taylor Society, New York.

Winfield to Have City Manager

After having twice defeated the City-Manager plan a proposal for its adoption was carried by a majority of 471 votes at Winfield, Kan., on Nov. 2.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

The Utah Society of Engineers, at a recent meeting, went on record in favor of the vigorous prosecution of a plan for the development of arid lands and the use of flood waters and the further development of irrigation in Utah in general as outlined by A. F. Parker, chief engineer of the Utah Water Storage association. Mr. Parker presented a draft of a bill which, it is hoped, will be brought in some form before the next Utah legislature. The bill would create a state development service, following the suggestion rather than the general outlines of the U. S. Reclamation Service.

The Technical Club of Dallas, Tex. has perfected an arrangement whereby its members will exchange engineering papers with members of a similar club in the City of Mexico.

The Engineers Club (Houston, Tex.), at a joint meeting with the Houston Realty Board held Oct. 28, was addressed by Mayor A. E. Ammerman, John T. Scott, M. E. Foster and M. E. Tracy. The Manchester purchase and port improvements were discussed.

The Rochester Engineering Society, at its meeting Nov. 12 was addressed by G. F. Stickney, consulting engineer of Albany, N. Y., on "The Siphon Spillway Dam." The fact was brought out that there are 25 dams of this type in this country and several more are proposed.

The Cleveland Engineering Society, at its noonday meeting, Nov. 26, will be addressed by E. Arthur Roberts on "European Impressions." At the meeting Tuesday evening, Nov. 30, Fletcher Collins will speak on "Wrought Iron Pipe by Puddling Process."

The Texas Section, Am. Soc. C. E., at its annual meeting late in October, adopted a resolution urging the defeat of the Smith Bill (H. R. 12,466) permitting the granting of irrigation rights in Yellowstone Park, and also a resolution urging Congress to pass an amendment to the Federal Water Fower Act exempting national parks from use for waterpower purposes.

The California Section, American Water Works Association, held its first annual meeting in San Francisco Nov. 13, with about 75 members and guests present, representing the water departments of fifteen municipalities, the Railroad Commission and the Board of Fire Underwriters. Three papers were presented, as follows: "The Business End of the Waterworks," by O. E. Clemens, water sales manager, Spring Valley Water Co.; "The Centrifugal pump," by E. P. McMurtry, chief engineer, Krogh Pump & Machinery Co., and "Chlorination in California," by Ralph Hilscher, state board of health, Berkeley. Chlorination experience in San Jose and Sacramento was reported by J. W. Ford and Livingston Jenks, respectively, and comments on loss in water systems was made by members familiar with the systems at San Diego, Pasadena and San Francisco. The morning session, closed by a round table discussion, was followed by a luncheon at the engineers' club and the afternoon was spent in an automobile trip over the peninsula properties of the Spring Valley Company.

The Engineers' Club of the Youngstown District will hold a regular meeting Nov. 30. The principal speaker will be F. C. Coey, general manager of the Celluloid Co. of America, who will deliver an address on "Celluloid: Its Manufacture and Uses."

PERSONAL NOTES

C. D. FLANIGEN, JR., has recently accepted a position with the Southeastern Underwriters Association, Atlanta, Ga., as engineer in the municipal service department. He was formerly mine engineer for the American Zinc Co. of Tennessee.

P. B. SPENCER, formerly assistant engineer of structures of the New York, New Haven & Hartford R.R. Co., has been made engineer of structures with headquarters at New Haven, Conn.

F. J. PITCHER, assistant engineer in the bridge department of the New York, New Haven & Hartford R.R. Co., has been promoted to the position of assistant engineer of structures with headquarters at New Haven, Conn.

P. S. SMITH of the U. S. Geological Survey, and E. A. Holbrook and O. P. Hood of the U. S. Bureau of Mines have been appointed by the Interior Department to serve on the American Engineering Standards Committee.

WILLIAM B. BAMFORD, consulting engineer, has been elected mayor of Belmar, N. J., and is planning the adoption of the borough-manager type of government. Mayor Bamford is a member of the American Society of Civil Engineers.

S. V. ROLAND, formerly superintendent of the Western division of the Chicago Great Western R.R. at Clarion, Iowa, has been transferred to the Northern division with headquarters at St. Paul, Minn.

H. S. JONES, valuation engineer, Gulf, Mobile & Northern R.R., has been appointed chief engineer with headquarters at Mobile, Ala.

DUDLEY P. BABCOCK, formerly assistant engineer, New York State Department of Highways, has been appointed assistant engineer, Bronx Parkway Commission, Bronxville, N. Y.

H. W. WILLIAMS, formerly assistant engineer in the electrical department, Chicago, Milwaukee & St. Paul Ry. at Seattle, has been appointed special representative to the general superintendent of motive power with headquarters at Chicago.

JOHN S. MITCHELL, formerly chief draftsman with Niles Forge & Mfg. Co., Niles, Ohio, has taken a position as chief engineer and assistant manager for Ohio Structural Steel Co. at Newton Falls, Ohio.

CURTIS C. COLDWELL, formerly connected with E. I. du Pont de Nemours & Co., as reinforced concrete designer, has taken a similar position with the Lackawanna Railroad.

E. EVERETT HARKNESS has resigned from the staff of the Emerson Engineers to accept a position as production manager with C. H. Root Co., Bristol, Conn.

EDWIN D. CRUMB, formerly in the engineering office of the Automatic Sprinkler Valve Co. of America, Youngstown, Ohio, has accepted a position as junior assistant engineer in the New York State Highway Department.

T. J. STRICKLER, chief engineer of the Kansas Court of Industrial Relations, has resigned effective Dec. 1 to accept a position as engineer for the Empire Gas & Fuel Co., Bartlesville, Okla.

E. O. ADEE, recently assistant engineer on road work in Hamilton County, Kan., has been appointed resident engineer of Federal Aid Project No. 49 in Ottawa County, Kan.

L. K. SHERMAN, president of the American Association of Engineers, testified Nov. 10 before the Calder Committee on Reconstruction in Chicago. He presented facts regarding the housing shortage based on his experience as president of the U. S. Housing Corporation.

HOWARD L. DICK, acting city engineer, has been appointed city engineer, Kingston, Ont., Canada.

LIEUTENANT-COLONEL W. C. WEEKS, Corps of Engineers, U. S. A., formerly chief of the construction section, under the engineer, 8th Corps Area, Ft. Sam Houston, Tex., has recently been assigned to duty as assistant to the district engineer at the Wilson Dam, Florence, Ala.

ERNEST A. TAYLOR has resigned as district engineer for Fayette County, W. Va., and is now with the Missouri State Highway Department as project engineer, assigned to Division No. 1 at St. Joseph, Mo.

ALLAN F. OWEN, for several years chief engineer for George C. Nimmons & Co., Chicago, has opened an office as structural engineer in the Marquette Building, Chicago.

FRANK HOLBROOK has recently been appointed superintendent of highways for Webster, Mass.

OBITUARY

WARD BALDWIN, consulting engineer, died Nov. 15. He was professor of civil engineering at the University of Cincinnati for a number of years. He acted as consulting engineer for the Cincinnati Rapid Transit Commission and made a valuation of the properties of the Cincinnati Traction Co. for the city.

THOMAS W. CLARKE, engineer for the Standard Oil Co. of New Jersey, died in Tampico, Mexico, Oct. 28. He was born in Roxbury, Mass., 1872, and received his engineering education at Massachusetts Institute of Technology. Upon leaving college he was associated with Manning, Maxwell & Moore, New York. During the Spanish-American War he served as assistant to the chief engineer at the Mare Island Navy Yard. In 1902 he began his service with the Standard Oil Co. as plant engineer of the Eagle Works. In 1905 he was sent to China for the Standard Oil Co. of New York, where he was superintendent of construction and designing engineer in South China. In 1908 he returned to the United States and was assigned to the S. T. Baker Oil Co. to build a compounding and exporting plant for handling galena oils. He later supervised the construction of domestic trade plants for the Standard Oil Co. of New Jersey throughout the United States and Canada. In 1913 he left the service of the Standard Oil Co. to become vice-president and engineer, New England Foundation Co. During the World War he served as traveling engineer, Wood Ship Division, U. S. Shipping Board. In February, 1920, he re-entered the service of the Standard Oil Co. of New Jersey to do special engineering work. He was assigned to the Cia Transcontinental de Petroleo, S. A., arriving in Tampico, Mexico, March, 1920. While in Mexico, in addition to his company interests, he promoted the following projects not only to benefit the oil companies operating in Mexico but the whole community: Dredging of the Chijol Canal, increasing Tampico water supply, improvements to Tampico and Tuxpam harbors, and the cleaning up of Tampico and Tuxpam to prevent an epidemic of yellow fever.

CHESTER A. THOMAS, engineer, died Nov. 11 at Dawson, Y. T., Canada. He was born in Los Angeles, Cal., 1874, and was graduated from Leland Stanford University, 1898. From 1899 to 1904 he was assistant engineer and chief engineer of mining operations, United Verde Copper Co., Jerome, Ariz. Later he was connected with the Montezuma Copper Co., Sonora, Mexico. From 1904 to 1906 he was in charge of mine examination for the Guggenheim Exploration Co. In 1906 he became resident manager, Yukon Gold Co., Dawson, Y. T., Canada. During his connection with this company his most important activities included the construction and operation of several hydraulic mines, seven gravel dredges, three electric grain elevators, a 2,500-hp. power-plant with 5-mile water system and 50 miles of transmission line.

BUSINESS NOTES

SUES ENGINEERING COMPANY, structural engineers, announce the opening of an office in Chicago, Ill.

THE PACIFIC CONSTRUCTION CO., the Pacific Dredging Co., and Loomis, White, Henry & McDonald have merged their interests with a capitalization of $5,000,000. Headquarters will be in Vancouver, B. C., with a branch in Montreal.

CLIFFORD F. MESSINGER, for 11 years connected with the Chain Belt Company as Rex Mixer sales manager, advertising manager and assistant to the vice-president, has been appointed general sales manager for the company at Milwaukee, Wis.

R. F. MACDONALD, formerly with B. F. Goodrich Co., Akron, Ohio, has joined the staff of Harrington, Howard & Ash, Akron, Ohio.

THE MANISTEE IRON WORKS CO., Manistee, Mich., manufacturer of Roturbo centrifugal pumps, vacuum pumps, condensers, etc., has opened a Pacific Coast office in the Rialto Building, San Francisco which will be in charge of L. M. Page. The company expects to open branches also at Los Angeles, Portland and Seattle. These offices will also be under the supervision of Mr. Page.

COLONEL FRANK E. SMITH has been elected director and first vice-president of the Republic Motor Truck Co., Alma, Mich.

ARTHUR G. SPURLOCK, for the past four years treasurer of the American Refractories Co., has been appointed treasurer of the H. H. Robertson Co., Pittsburgh.